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Does basal metabolism really influence the prognosis of childhood obesity?

Summary

Introduction, hypothesis and objectives: Childhood obesity is one of the greatest social and health problems of the 21st century. Exogenous obesity consists in the pathological increase in body mass due to the imbalance between caloric intake and expenditure. Different studies and preventive protocols have been carried out with the aim of solving this health problem. Likewise, differentetiopathogenic factors such as metabolism and various diagnostic methods such as bioelectricalimpedance, have been described. The hypothesis is based on the assumption that a lowbasal metabolic rate in the context of a caloric imbalance could lead to an increase in the incidence of exogenous or primary obesity with an increase in fat mass. The objectives of the study are to carry out an epidemiologicaldescription of the variables of the database obtained on childhood obesity from the clinic. To investigate whether there is an inversely proportional relationship between basal metabolism and a patient's fat mass. To check if there are differences between sex and age of the patients with respect to the variables under study (basal metabolism and fat mass). To analyze whether there is a directly proportional relationship between basal metabolism and lean mass. To investigate whether there are differences in basal metabolic rate between patients according to sex and whether there are differences in fat mass between patients according to sex. To determine whether thereare differences in basal metabolism between patients according to age (7-10 years and 11-14 years) and whether there are differences in fat mass between patients according to age (7-10 years and 11-14 years). To stipulate whether patients with early detection (age range: 7-10 years) and late detection (age range: 11-14 years) of childhood obesity can have a better evolution in fat mass.

Material and methods: A total of 19 articles were used as bibliographic references, obtained from different digital sources such as Science Direct, CNN, La Vanguardia, SciELO and Pubmed, and from organizations such as the Basque Government and the University of Cantabria Library. In addition, the certificate of authorization for the epidemiological exploitation of the OSI Araba database (code 01/2019) has been obtained. Excel and SPSS Statistics 29.0.2.0 were used to perform the statistical analysis.

Conclusion: An epidemiological description of the variables of the database obtained on childhood obesity from the clinic has been carried out. An inversely proportional relationship between basal metabolism and fat mass in a patient has not been found. There is no directly proportional relationship between basal metabolism and lean mass. Differences in basal metabolism between patients according to sex are described. There are no differences in fatmass between patients according to sex. There are differences in basal metabolism between

Patients according to age (7-10 years and 11-14 years). No differences in fat mass between patients according to age (7-10 years and 11-14 years) were described. Patients with early detection (age range: 7-10 years) and late detection (age range: 11-14 years) of childhood obesity have a better evolution in fat mass.

Keywords: childhood obesity, bioelectrical impedance, fat mass, basal metabolism, lean mass

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Introduction

In the pediatric field, childhood obesity hasincreased significantly in recent years and is a major global health challenge in the 21st century. Due to its seriousness and importance, different action plans have been carried out to promote primary prevention measures that consist of healthy lifestyle habits. In addition, there are publications by the World Health Organization (WHO) that confirm its severity and in which preventive recommendations are indicated.[1]

In Spain, a project called Estudio de ALimentación, Actividad física, Desarrollo INfantil y Obesidad en España (ALADINO 2019) has been carried out, as part of the fifth wave of the COSI EURO WHO initiative. In addition, this project is a cross-sectional descriptive study,[2] using the Child Obesity Surveillance Initiative of the WHO Regional Office for Europe.[3]

The ALADINO 2019 project concludes that 23.3% of Spanish schoolchildren are overweightand 17.3% are obese. All these data lead to 40.6% of infants being overweight. In addition, it is noteworthy that overweight is more prevalent in women (24.7%) and obesity is more prevalent in boys (19.4%). Likewise, after the study, Spain has been considered as the second country with the highest prevalence of overweight and the sixth country in terms of obesity.[4]

In the Basque Country, there has been an increase in the incidence of childhood obesity due to the following causes: the increase in overweight, poor diet (decrease in the consumption of fruit and vegetables), sedentary lifestyle, considering socioeconomic inequalities in physical activity practices and the time spent by children on television and other screens.[1] As a result of this increase, the Basque Country's Childhood Obesity PreventionStrategy has been drawn up**,** with the sloganSANO. This tool promotes measures in five areas (family, school, health centers, private sector and community environment) with the aim of promoting physical activity and healthy eating, with the aim of enabling children and young people to have a healthy life and reducing the risks of unhealthy behaviour**.**[1]

This major social and health problem known as obesity consists of the pathological increase in body mass. There are two types of obesity: endogenous obesity and exogenous or primary obesity. Endogenous obesity has an organic etiology, while primary obesity is due to an imbalance between caloric intake and expenditure, since food intake increases with thedecrease in physical exercise or other activities that favor energy expenditure.

Etiopathogenic factors of obesity include a poor eating habit and an increase in sedentary lifestyles due to the lack of physical exercise and the increase in the use of screens. Indirectly,socio-economic status and paternal-maternal educational level also play a role.[2] Likewise, obesity is favored by other factors such as epigenetics,[5–7] related to the hypothesis of the "thrifty phenotype",[5] the deficiency of thehormone leptin;[6] among others.

Maternal factors,[5,8–10] such as maternal obesity,[5, 8] diabetes mellitus (gestational or type I),[5,9] dyslipidemia, high blood pressure, dietary alteration (interruption of breastfeeding, consumption of formula or cow's milk, restriction of iron, zinc, calcium and magnesium, and consumption of sugary drinks), being a smoker, their exposure to pollutants, the mother's psychological situation (depression and stress) cause an increase in the incidence of childhood obesity.[5]

Also, the genetic factor[6,10,11] with respect to the Coronin7 gene (CORO7 or CRN7) and mutation in the leptin gene should be highlighted.[11] Hypothalamic lesions or tumors, sleep deprivation (low quantity and poor quality of sleep), infant disorders such as autism spectrum disorder and attention deficit hyperactivity disorder, and the psychosocial andemotional situation of the child must also be taken into account.[5]

On the other hand, the basal metabolism of the child must be taken into account, because a slowmetabolism leads to a lower lean mass (LM), which consists of connective tissue, muscle and bone, and a higher fat (FM), which leads to an increase in the incidence of obesity.[12] It is also necessary to take into account the variability of basal metabolic rate according to age, since its values are high in childhood and subsequently progressively decrease as the age increases.[13]

Regarding to diagnosis, on the one hand, direct methods are aimed at investigation, since the fatof the cadaver is measured; therefore, it is not useful in routine clinical practice. On the other hand, indirect methods include anthropometric measurements (weight, height, body folds and abdominal circumference) and specific methods such as imaging tests. Finally, there are modern techniques based on electrical conductance, including dual-photon X-ray absorptiometry (DEXA) and bioelectrical impedance (BIA), among others.[14]

BIA is the most widely used modern method forquantifying body composition.[15] This technique is based on the principle that tissues with a high electrolyte fluid composition are conductive, while other tissues such as fat and bone are not good electrical conductors. In addition, it assesses the ratio of total body water to body impedance,[16] which is measured by using eight electrodes placed on the body, of which two are placed on each hand and foot.[17]

Body composition values such as lean mass, body fat percentage, fat mass, total body water, body cell mass, extracellular mass, body mass index (BMI) and basal metabolism (BM) are estimated by obtaining the body water value.[16,17] On the other hand, it measures phase angle, a good predictor of malnutrition that reflects the quantity and quality of soft tissue; now, it is a configuration-dependent value in themeasure.[19]

The usefulness of this technique is very feasible due to its multiple advantages, among which we can highlight that it is a simple, useful, fast, efficient (relatively cheap), effective, non- invasive, safe, mobile technique that does not require prior specialization.[15,16,18] However, there are certain factors such as body temperature, variations in electrode placement, previous solids consumption, and body position; that diminish the effectiveness of such a technique. Therefore, the application of other reference techniques is necessary for its validation.[15]

Likewise, the BIA considers body hydration asa constant variable, but there are physiological (gender, age, ethnicity, hormonal cycle, pregnancy, physical activity, time of day) and pathological (obesity, diseases, medications) processes that alter it. In addition, each body structure contributes unevenly in the BIA; for example, the trunk contributes less than the limbs, and such inequity can alter the body impedance ratio.[16]

The hypothesis to be studied is the assumption that a low basal metabolism in the context of a caloric imbalance could lead to an increase in the incidence of exogenous or primary obesity with an increase in fat mass.

To this end, some primary objectives are investigated:

1. To carry out an epidemiological description of the variables in the database obtained on childhoodobesity from OSI ARABA.
2. To investigate whether there is an inversely proportional relationship between basal metabolism and a patient's fat mass.
3. To check if there are differencesbetween sex and age of the patients with respect to the variables under study (basal metabolism and fat mass).

Likewise, some secondary objectives are investigated:

1. To analyze whether there is a directly proportional relationship between basalmetabolism and lean mass.
2. To investigate whether there are differences in basal metabolic rate between patients according to sex and whether there are differences in fat mass between patients according to sex.
3. To determine whether there are differences in basal metabolism between patients according to age (7- 10 years and 11-14 years) and whether there are differences in fat mass between patients according to age (7- 10 years and 11-14 years).
4. To stipulate whether patients with earlydetection (age range: 7-10 years) and late detection (age range: 11-14 years) of childhood obesity can have a better evolution in fat mass.

Materials and methods

In order to obtain the literature on childhood obesity, the following search strategy has been proposed. First of all, with regard to the situation of childhood obesity in the Basque Country, a search was carried out on the BasqueGovernment's website (Euskadi.eus) and in the section "Departamentos, organismos y entidades del Gobierno", "Salud" was selected. The website of the Department of Health has been opened and by downloading the page under "Trabajamos en las siguientes áreas" "Salud alimentaria y nutrición""Salud alimentaria y nutrición" has been selected and of the three possible results, "Estrategia de Prevención de la Obesidad Infantil en Euskadi" has been selected, which has been the source of information of interest. As part of this result, the information from the tabs "Introducción al documento" and "Por qué una estrategia de prevención de la obesidad infantil para Euskadi" was used.

Through the SciELO electronic library, the search for information on the ALADINO 2019 project has been carried out.

Secondly, in order to find information on the etiopathogenesis of childhood obesity, the following terms have been searched on the ScienceDirect website ("thrifty gene hypothesis AND childhood obesity") and the following filters have been applied: in "Year(s)" the searchhas been limited to 5 years ago (2018-2023), "Review articles" in "Article type", "Openaccess & Open archive" in the "Access type" section.

Likewise, to complete the search on the etiopathogenesis, on the one hand, information has been sought in the CNN, using the terms "metabolismo basal, masa magra y masa grasa".On the other hand, in La Vanguardia the following terms have been searched: "declive metabolismo edad", and the following filters have been added: "Comer" in "Sección" and "06/10/2018" in "fecha inicio" and "06/10/2023" in "fecha fin" (5 years since I searched, on October 6, 2023).

Thirdly, the information on diagnostic techniques has been obtained at the University of Cantabria Library, searching for "obesidad infantil" and the following filters have been added: in "Limita la búsqueda" the "Texto completo en línea " has been selected, in "Tipo de Documento" it has been chosen "Tesis doctorales, Trabajos fin de máster, Trabajos fin de grado", in " LOCALIZACIÓN EN LA BUC" we have selected "TFG/TFM en Catálogo BUC", in "Términos temáticos" we have selected "proyectos y disertaciones académicas"and "obesidad en el niño", and the rest of the terms have been excluded from the list (34 items). The search for data on BIA has been carried out through the PubMed electronic library using the terms: "(BIOELECTRIC IMPEDANCE) AND (OBESITY) AND (CHILDREN)", and the following filters have been added: "Free full text, Associated data, Humans, English, Spanish, Adolescent: 13-18 years, Child: 6-12 years, from 2018/10/6 - 3000/12/12".

With regard to bioethics, due to the limitation of being a sixth-year medical student, I have not been able to have direct contact with patientsand I have not been able to have access to their medical records. Therefore, the pediatricendocrinology team of OSI ARABA, which includes my tutor, Dr. Ignacio Díez López; has shared with me the anonymized, untraceable and coded database.

This database has been generated from the usualclinical practice of the last 5 years of patients who have passed through the consultation with the following inclusion criteria: exogenous childhood obesity greater than two standard referrals and an age greater than 6 years.

During the clinical practice, the health professionals spoke with the parents and patients, they were given dietary guidelines and verbal consent was given, indicating that thedata are registered in the protected database in the Osakidetza network.

This database with the code 01/2019 has been authorized by the Clinical Research Ethics Committee (CEIC) Araba University Hospital with a favorable opinion (authorization certificate) for the registration of patients and for its epidemiological exploitation by theAraba Integrated Health Organization (OSIAraba).

For the statistical analysis, the statistical tool SPSS Statistics 29.0.2.0 has been investigated if there is an inversely proportional relationship between the basal metabolism and the fat mass of the patients, a Pearson correlation is performed, a parametric test to examine the direction and magnitude of the association between the variables. The scatter plot with the regression line has been obtained.

Pearson's statistical correlation test can take values between -1 and +1. If a negative value is obtained, the relationship between variables is inversely proportional and the line of thegraphical representation is decreasing. However, if the value obtained is positive, the relationship between variables is directlyproportional and the line of the graphic representation is increasing.

In addition, in order to check if there are differences between sex and age of the patients with respect to the variables under study (basal metabolism and fat mass), using SPSS Statistics, the Student's t-test of independent samples has been performed. This test consists of a parametric statistic to compare two means in independent samples when one of the study variables is quantitative, the other is qualitative and there are only two groups. It should be noted that the variable "sexoH1M0" did not have any attributed value; therefore, the values 0 and 1 have been added with their label "mujer" and "hombre", respectively. Also, the variable " edad 1ª visita" has been recoded and anew name ("edad1") and label ("edad1") hasbeen decided, detailing values 1 (label: "7-10 años") and 2 (label: "11-14 años").

Finally, in order to study whether patients with early detection of childhood obesity can have a better evolution in fat mass, a Student's T test ofindependent samples has been carried out in SPSS Statistics. It has been carried out in the same way as the previous Student's T-tests, but in "Test variables" the data on fat mass from thefirst visit and the data at one year after the visit must be inserted.

For the interpretation of the Student's t-test of independent samples, it is first necessary to evaluate the Levene test of equality of variances. In this test, if a $p<0.05$ value is obtained, equal variances are not assumed. However, if a $p>0.05$ value is obtained, equal variances are assumed. With this in mind, the interpretation of Student's T is made.

On the one hand, if the Levene test does not assume equal variances, the significance of two factors of the Student's T of independent samples is analyzed, not assuming equal variances.

On the other hand, if equal variances are assumed in Levene's test, the significance of two Student's T factors from independent samples is analyzed, assuming equal variances.

In both statistical tests, a statistically significant result is considered when a $p<0.05$ value is obtained. However, a $p>0.05$ value is interpreted as a non-statistically significant result.

Results

Data from 100 patients have been collected from the database, of which 61 are women and 39 are men. In addition, 56 of these are patients aged 7-10 years and 44 are patients aged 11-14 years. A total of 29 variables were analyzed. It has been possible to specify that 28 of them have been quantitative variables, which have been "paciente", "edad 1ª visita", "peso 1ª visita", "talla 1ª visita", "IMC 1ª visita", "MB 1ª visita", "MG 1ª visita", "MM 1ª visita", "ACT 1ª visita", "peso al año", "talla al año", "IMC al año", "MB al año", "MG al año", "MM año", "ACT al año", "peso x3 años", "talla x3 años", "IMC x3 años", "MB x3 años", "MG x3 años", "ACT x3 años", "diferencia masa grasa 1 año", "diferencia masa grasa 3 años", "metabolismo basal teórico", "diferencia real MB teórico" y "diferencia MG a los 3 años". On the other hand, the qualitative variable has been "sexoH1M0".

In addition, other data and graphs have beenfound in the database, such as those related to patients who gain weight at one year, those who lose weight at one year, those who gain weightat 3 years, those who lose weight at 3 years, etc.

Secondly, in order to assess the inverselyproportional relationship between basal metabolism and fat mass, a correlation value of Pearson=0.215 with a p=0.032 ($p<0.05$) value was obtained, a statistically significant result.

Next, to assess the directly proportional relationship between basal metabolic rate and lean mass, a correlation value of Pearson=-0.215 with a p=0.032 ($p<0.05$) was obtained, being a statistically significant result.

On the one hand, the possible differences between sex and the study variables have been assessed. Regarding the existence of differences between males and females with respect to basal metabolism, a significance of $p<0.001$ ($p<0.05$) has been obtained in Levene's test of equality of variances; therefore, equal variances have not been assumed. Next, the significance of the Student's T test of independent samples not assuming equal variances of two factors was $p<0.001$ ($p<0.05$), a statistically significantresult.

In addition, in relation to the existence of differences with respect to fat mass between men and women, a significance of p=0.002 ($p<0.05$) has been obtained in Levene's test of equality of variances; therefore, equal variances have not been assumed. In addition, the significance of the Student's T of independent samples not assuming equal variances of two factors was p=0.523 ($p>0.05$), which was not a statistically significant result.

On the other hand, possible differences between age and study variables have been evaluated. Regarding the existence of differences between patients aged 7-10 years and those aged 11-14 years with respect to baseline metabolism, a significance of p=0.047 ($p<0.05$) has beenobtained in Levene's test of equality of variances; therefore, equal variances have not been assumed. Next, the significance of the Student's T of independent samples notassuming equal variances of two factors wasp=0.004 ($p<0.05$), a statistically significant result.

Likewise, with respect to fat mass between patients aged 7-10 years and those aged 11-14 years, a significance of p=0.722 ($p>0.05$) was obtained in the Levene test of equality of variances; therefore, equal variances have been assumed. Likewise, the significance of the Student's T of independent samples assuming equal variances of two factors was p=0.590 ($p>0.05$), being a non-statistically significant result.

Finally, in relation to the probability that early detection of childhood obesity triggers an improvement in fat mass values, as already calculated in the previous result**,** there are no differences between patients aged 7-10 years and those aged 11-14 years with respect to fat mass.

Next, in the group statistics it has been observedthat in patients aged 7-10 years the mean fatmassatthefirstvisithasbeen36.587500 and one year after the visit it has been 35.508929. Inpatients aged 11-14 years, it has been observed that the mean fat mass at the first visit was37.120455 and one year after the visit it was 34.845455.

Discussion

Childhood obesity is a health problem that is currently on the rise in our society. Due to its strong associations with various problems in infants, this study has been prepared to assess the impact of this pandemic on the population under study.

The results obtained in our population have been based on the statistical data of thisdatabase, which contains 29 variables that have been used for the study of one hundred children in our sample. In this database there is great variability with respect to the age (7-14 years) and gender (male and female) of the population.However, our sample is biased as it refers to the children seen in the consultation.

As Drayer[12] has shown, slow metabolismleads to a high amount of fat mass. However, in our study population there is a directly proportional relationship between basal metabolic rate and fat mass. This means that in the child population, the lower the metabolism, the lower the fat mass values. Consequently, thenull hypothesis consisting of the inverselyproportional relationship between basal metabolism and fat mass in a patient is rejected (Figure 1).

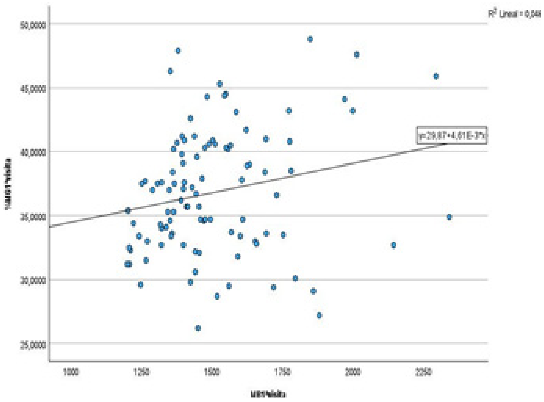

Figure 1 Scatter plot: relationship between basal metabolism and fat mass.

As Drayer[12] has shown, slow basal metabolism leads to a low amount of lean mass. However, in our sample there is an inversely proportional relationship between basal metabolic rate and lean mass. That is, infants in our sample with a low basal metabolism have a high lean mass. Therefore, the null hypothesis consisting of the directly proportional relationship between basal metabolic rate and lean mass is rejected (Figure 2).

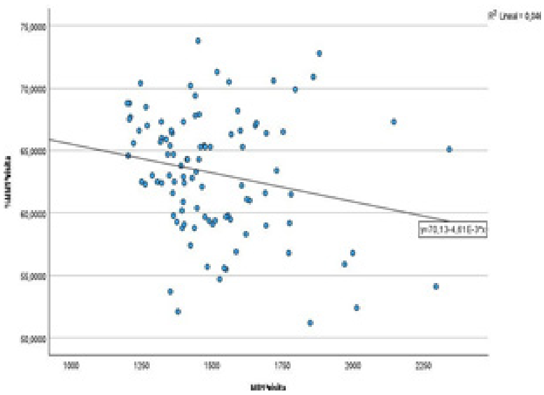

Figure 2 Scatter plot: relationship between basal metabolism and lean mass.

On the one hand, there is a significant differencein growth and metabolism between the sexes, due to the fact that males show faster growth from preimplantation phases, as stated by Dearden et

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al.[10] In relation to this result, differences between males and females with respect to basal metabolism have been described in our study population. As a consequence, the null hypothesis that consists of equality between men and women with respect to basal metabolism is rejected (Figure 3).

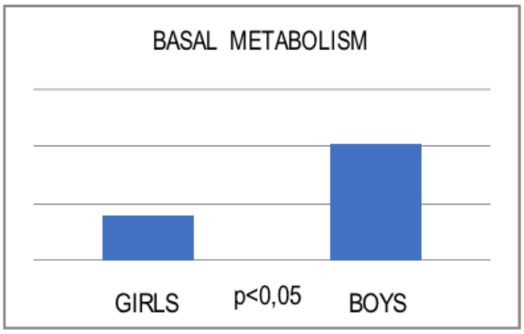

Figure 3 Bar chart: relationship between sex and basal metabolism.

In addition, some authors[15,17] have highlighted the existence of differences between boys and girls with respect to fat mass, with girls having a higher amount of fat mass. However, in our sample there are no differences between men and women with respect to fat mass, so the null hypothesis is confirmed (Figure 4).

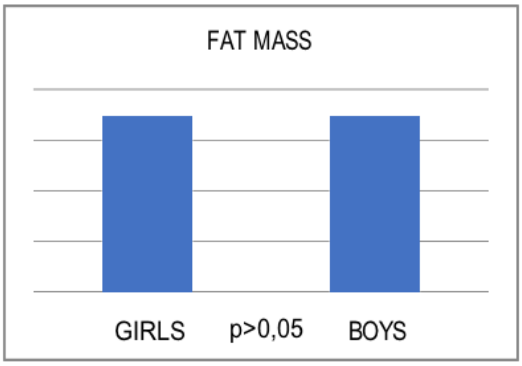

Figure 4 Bar chart: relationship between sex and fat mass.

On the other hand, it has been reported that basal metabolic values are high in childhood and that from that moment on, these values progressively decrease as the age is advanced.[13] In addition, in our study population it has been obtained that there are differences between patients aged 7-10 years and those aged 11-14 years with respect to basal metabolism. Consequently, the null hypothesis that there were no differences between patients aged 7-10 years and those aged 11-14 years with respect to basal metabolism is rejected (Figure 5).

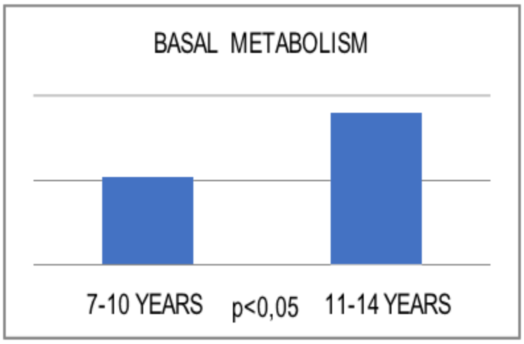

Figure 5 Bar chart: relationship between ageand basal metabolism.

As Kreissl et al.[17] have shown, fat mass increases between infancy and 6 months of age, after which there is a decrease in fat mass until 10 years of age. However, in our sample there are no differences between patients aged 7-10 years and 11-14 years in our population with respect to fat mass, so the null hypothesis is confirmed (Figure 6).

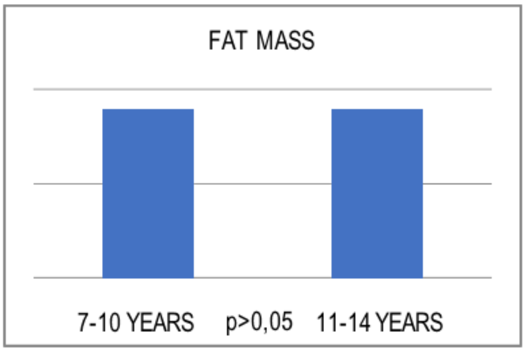

Figure 6 Bar chart: relationship between ageand fat mass.

Some authors[3, 8, 14] have highlighted the great benefits and advisability of lifestyle care for parents; Above all, in the mother and in the youngest children when it comes to obtaining clinically significant results in terms ofavoidable chronic complications caused by childhood obesity, highlighting that school ageis the preferable vital time in terms of the persistence of adherence to these measures in adulthood. Likewise, in our population it hasbeen concluded that early detection (age range: 7-10 years) and late detection (age range: 11-14 years) of this disease triggers an improvement infat mass values (Figure 7).

Group Status			
	edad1	N	Stocking
%MG1ªvisita	7-10 years	56	36,587500
	11-14 years	44	37,120455
%MGalaño	7-10 years	56	35,508929
	11-14 years	44	34,845455

Figure 7 Evolution in the relationship between age and fat mass one year after earlydetection (age range: 7-10 years) and late detection (age range: 11-14 years) of childhood obesity.

Finally, it should be noted that the results have been obtained using bioelectrical impedancemetry, which is validated for long- term monitoring of the same population. The efficacy of this technique is affected by several factors, so it would be necessary to use other reference techniques for the validation of all these results and their interpretations. Consequently, I would like to carry out future research with our database using other techniques to ratify the veracity of the results obtained with the BIA.

Conclusion

After carrying out this work, it has been possible to draw the following conclusions fromour study population:

1. An epidemiological description of the variables of the database obtained on childhood obesity from OSI ARABA has been carried out.

2. An inversely proportional relationship between basal metabolism and fatmass in a patient has not been found.
3. There is no directly proportional relationship between basal metabolism and lean mass.
4. There are differences in basal metabolism between patients accordingto sex.
5. There are no differences in fat massbetween patients according to sex.
6. There are differences in basal metabolism between patients accordingto age (7-10 years and 11-14 years).
7. No differences were found in fat mass between patients according to age (7- 10 years and 11-14 years).
8. Patients with early detection (age range: 7-10 years) and late detection (age range: 11-14 years) of childhood obesity have a better evolution in fat mass.

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Conflicts of interest

The authors declare there are no conflicts of interest.

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