

Attention deficit hyperactivity disorder due to clinical subtype in schoolchildren with obesity and overweight

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Abstract.

Background: The symptoms of Attention Deficit Disorder (ADHD) have been linked to overweight and / or obesity in schoolchildren who suffer from it. Objective: to know the association between ADHD, obesity and / or overweight by Body Mass Index (BMI) in a group of schoolchildren. **Methods:** to classify children with ADHD, the Connors scales were used, a clinical history was performed, as well as evaluation and behavioral observation of each child by pediatric psychiatry, neurology and psychology, according to the diagnostic criteria of DSM-5. **Results:** The BMI between the two study groups presented a significant difference ($p < 0.0001$). No correlations were found between the subclinical type of ADHD in either of the two study groups. When separating the population by the subclinical type of ADHD (Combined, Hyperactive-Impulsive and Combined), no significant differences were found with respect to BMI ($p = 0.12$). In the population of overweight infants, two subgroups were created; with obesity and without obesity, no correlation was found between the subclinical type and the BMI (correlation coefficients $p = 0.086$ and $p = -0.129$ respectively). Subsequently, the overweight and non-overweight population was analyzed with respect to their gender and

subclinical type, it was found that there is an association between the variable gender and clinical subtype ($p < 0.05$ in both genders). **Conclusion:** This study provided evidence of a significant association between ADHD and obesity / overweight in school-age girls and boys.

Keywords— Attention deficit hyperactivity disorder, body mass index, weight, obesity, school children. attention deficit hyperactivity disorder, body mass index, weight, obesity, school children.

I. INTRODUCTION

Attention deficit hyperactivity disorder (ADHD) is defined as a chronic developmental condition, characterized primarily by a decrease in attention. Probably due to difficulties in both sensory and motor inhibitory control that are manifested on the one hand by responding to the majority of sensory stimuli and on the other as behavioral and cognitive impulsiveness and motor and verbal restlessness. (DSM-5) [1]

The incidence of the disease within the child population of the United States of America, according to the DSM-IV, has been quantified between 3 and 5%, this being the most common behavioral condition during childhood, (Nassem S

et al, [2] documented an incidence of between 3% and 16%, while Guardiola et al., 2000 [3] conducted a study that included 484 first grade children, found that it affects 18% of them when applying the criteria of the DSM IV, and 3.5% when using neuropsychological criteria for diagnosis. The male-female ratio varied depending on the populations studied; in the clinical population it was 6: 1 and in the open population 3: 1.

Cantú-Ochoa [4], argues that Mexico's statistics regarding the incidence of ADHD are incomplete, since according to the author, several studies carried out primarily in health centers reveal only the percentage of cases diagnosed with ADHD that were treated. in medical institutions and the figures vary from 10.3% to 45%.

In ADHD it describes the difficulties in inhibitory control, and this lack responds to both sensory stimuli and behavioral impulsivity; In this context, overweight and obesity could be part of the comorbidity of the subject who suffers from it.

Overweight and obesity are defined by the World Health Organization (WHO) as an abnormal or excessive accumulation of fat that can be harmful to health [5].

According to their origin, obesity can be classified as endogenous and exogenous. The endogenous is the least frequent of these two types, since only between 5 and 10% of obese people present it, this type of obesity is due to problems caused by the dysfunction of some endocrine gland. On the other hand, exogenous obesity is one that is due to an excess in food or certain sedentary habits, in other words, exogenous obesity is the most common and is not caused by any disease or alteration of the organism, if it is caused for the habits of each person. This type constitutes approximately 90 to 95% of all cases of obesity in Mexico [6].

The nature of the condition is generated by the interaction between various factors: behavioral, sociocultural, environmental, physiological, genetic and epigenetic and environmental [7].

In Mexico, surveys show that obesity has now displaced malnutrition as the main challenge to be solved [8].

Data from the 2012 National Health and Nutrition Survey reported that the prevalence of overweight and obesity in Mexican adults 20 years or older was 71.3% (obesity 32.4% and overweight 38.8%), also reported that obesity is higher in the female sex (37.5% vs. 26.8%) [9].

Obesity is a worldwide epidemic that affects the quality of life of those who suffer from it, increases the risk of acquiring diseases and raises the costs of health care in virtually every country in the world (WHO., 2016) [10].

Currently, Mexico and the United States occupy the first places of global prevalence of obesity in the adult population (30%), which is ten times higher than in countries such as Japan and Korea (4%) .8 In our country, the tendencies of overweight and obesity in the different national surveys show a constant increase in prevalence over time. From 1980 to date, the prevalence of obesity and overweight in Mexico has tripled, reaching alarming proportions.

Until 2012, 26 million Mexican adults were overweight and 22 million were obese, which represents a very important challenge for the health sector.

The global experience indicates that the correct attention to obesity and overweight require efficient multisectoral strategies to be formulated and coordinated to enhance the protective factors towards health, particularly to modify individual, family and community behavior [11].

In this context, stimulant medication for one of the most common pediatric psychiatric conditions such as ADHD has raised concerns about the possible link between ADHD and the rapid increase in obesity rates among children. (Detection guide SSA. Mexico, 2015) [12]

A study in adults with retrospective diagnosis of ADHD in childhood showed a statistically significant association between ADHD, overweight (OR 1.57; 95% CI = 0.99, 2.70) and obesity (OR 1.69; 95% CI = 1.01, 2.82) after Control the Major Depressive Disorder factor. But with Binge Eating Disorder (in the previous 12 months) the association was not significant (OR 1.41, 95% CI = 0.76-2.53) Some methodological problems detected were the lack of formal diagnosis of ADHD in adulthood, obviate whether treatment for ADHD is received and underestimate the prevalence of Binge Eating Disorder by not controlling the tendency to hide these shameful symptoms and limit their search in 12 months [13].

Clinicians should be aware of the risks of obesity in children with ADHD and particularly the use of stimulants. Additional research is necessary to create appropriate interventions to prevent obesity in children with ADHD.

MATERIALS AND METHODS:

Study design:

The sample for this study was made up of schoolchildren residing in the metropolitan area of Mexico City during the year 2018 linked to a public-school institution, located in the Iztacalco and Iztapalapa delegations in Mexico City. The type of sampling was not probabilistic, inclusion, exclusion and elimination criteria were established.

Inclusion criteria.

Procedures

Experimental group

ADHD group with obesity and / or overweight. The experimental group was formed with children from 7 to 12 years old, enrolled in official schools of basic education, with indicators of inattention, hyperactivity and impulsivity, and / or behavior and poor school performance, according to the diagnostic criteria of the DSM- 5, overweight and obese according to the WHO criteria.

Control group. ADHD group without obesity and / or overweight, the control group was formed with girls and boys from 7 to 12 years of age, enrolled in official elementary schools, with indicators of inattention, hyperactivity and impulsivity, and / or behavior and low school performance, according to the diagnostic criteria of the DSM-5, without overweight and obesity.

Exclusion criteria for both groups. School children with hearing impairment, with alterations in their understanding for their age, neurological alterations, irregular school attendance.

Elimination criteria. Nonspecific diagnosis, Intellectual Coefficient less than 80, incomplete assessment.

According to the above, the study sample was formed by 280 boys and girls, distributed as follows 152 boys and 128

girls, with one ($x = 108.38$, or $= 20.97$.) according to age in months.

The experimental group was formed with overweight and obese boys and girls concentrated 55 infants, 33 boys and 22 girls with one ($x = 109.98$, or $= 18.16$)

The Control group was formed with boys and girls with ADHD without overweight and / or obesity, 178 infants, 94 boys and 84 girls were concentrated, with one ($x = 107.79$, or $= 16.15$)

Instruments

-Conners questionnaires for parents and teachers the "Conners scales" were designed by Keith Conners in 1969 [14]. Although these scales were developed to assess changes in the behavior of hyperactive children receiving pharmacological treatment, their use has been extended to pre-treatment evaluation process. These scales have become a useful instrument whose objective is to detect the presence of ADHD and other associated problems, by evaluating the information collected from parents and teachers [15].

The Conners scales have 2 versions (the original and the abbreviated) for both the parents and teachers' scale.

The Global Index (formerly the hyperactivity index ") contains 10 items of a global nature sensitive to the evolution of symptoms (initiation / change of pharmacological treatment, psychotherapeutic intervention, environmental factors).

Each section of the scales contains descriptions of symptoms that correlate with the diagnostic criteria of the DSM-IV.

The Conners Scales

CONNERS Behavior Questionnaire for Parents (C.C.I .; Parent's Questionnaire, C. Keith Conners). In their abbreviated form (CPRS-48) the 48 questions are divided into 5 factors:

1. Behavior problems
2. Learning problems
3. Psychosomatic complaints.
4. Impulsivity-Hyperactivity
5. Anxiety

In the abbreviated version * for teachers (CTRS-28) the 28 questions are divided into 3 factors:

1. Behavior problems
2. Hyperactivity
3. Overlook

Administration time: 5-10 minutes.

- Intelligence scale for WISC-IV school children, was applied to evaluate the Executive Functions and Intellectual Coefficient. This test includes five subtests. Verbal Comprehension (CV), which in turn is composed of the following subtests: Similarities, Comprehension, Information, Words in context; Perceptual Reasoning (RP), which is composed of the following subtests: Design with cubes, Concepts with drawings, Matrices and Incomplete Figures; Working memory (MT) that is composed of the following subtests: Digits Retention, Sequence of numbers and letters and Arithmetic and the Processing Speed Scale that includes the following subtests: Keys, Search for Symbols and Registers. It was applied by a psychologist without the presence of his parents. The test was applied according to the instructions of the WISC-IV Application Manual, in each subtest the child's age was taken into

account to determine the number of the reagent with which the application should start, since this will determine the final score in each subtest. (Wechsler, D., 2015) [16]. The scores in the IQ tests obtained were classified as follows:> 130 Very Higher; 120-129 Superior; 110-119 Normal High; 90-109 Normal; 80-89 Normal Low; 70-79 Borderline; 50-69 Mentally Deficient.

Anthropometry instruments. Weight and height measurements were obtained by medical and nursing staff from the trained Ministry of Health. A Remo brand scale was used, calibrated by trained personnel. Based on this information, the Z score of the Body Mass Index ($BMI = kg / m^2$) was calculated by age and sex. (WHO 2018)

Method

It was a non-experimental or ex post-factum, prospective, transversal, descriptive, comparative study with quantitative data. With the WISC-IV test, students with an IQ of less than 80 were identified to exclude them from the study sample. With the Conners questionnaires for parents and teachers and the observations of the disciplinary group, children with ADHD and obesity were classified and overweight was calculated by experts in the field.

Statistic analysis

Statistical analysis was performed using GraphPadPrism 7. Descriptive data were expressed as mean \pm SD, categorical data were expressed as proportions. All the variables were subjected to the Shapiro-Wilk normality test, none were distributed in a normal way, so non-parametric tests were used. To find differences between groups, the Man-Whitney tests were used, for an association between dichotomous variables, the X² Pearson test was used. The correlations between variables were evaluated by means of the Spearman coefficient. The level of significance was set at $p < 0.05$.

Results

The school population consisted of 280 schoolchildren, distributed in the following way 152 boys and 128 girls, with one ($x = 108.38$, or $= 20.97$.) By clinical subtype ADHD Combined 133 boys and girls with ($x = 110.58$ or $= 18.59$); ADHD Inattentos 93 ($x = 108.38$, or $= 20.97$); ADHD HIP-IMP 54 ($x = 111.81$, or $= 20.96$) (Table 1)

Table 1 shows that the prevalence of ADHD-C is higher, followed by ADHD-I compared to ADHD-IM. Regarding sex, only in the clinical subtype ADHD-I is the female sex older.

TABLE 1. POPULATION DISTRIBUTION BY SEX

ADHD	Clinical Subtype		TOTAL
	Men	Women	
C	78	55	133
I	32	61	93
HIP-IMP	42	12	54
Total	152	128	280

ADHD C. Combined, ADHD I. Inattention, ADHD HIP-IMP Hyperactive-Impulsive.

AND CLINICAL S

For the present study 280 infants diagnosed with ADHD were recruited, resulting in a prevalence of said disorder of 3.24%. Through the guidance provided by WHO (2007), the prevalence of overweight in the sample of children with ADHD was 36.43% (102 infants), the remaining 63.57% (178 infants) was employed as a Control group. The prevalence of obesity, evaluated with the guide mentioned above, was 20.00% (56 infants). Table 2 contains the demographic data of the study groups.

TABLE 2. DEMOGRAPHIC VALUES OF THE STUDY GROUPS.

Variable	Overweight	Control
Age, years (mean \pm SD)	8.9 (1.4)	9.3(1.6)
Age, months (mean \pm SD)	107.2(17.6)	111.9(20.2)
Men, boys (%)	58 (56.86)	94 (52.81)
Women, girls (%)	44 (43.14)	84 (47.19)
Weight, g (mean \pm SD)	37.4(6.04)	24.9(5.5)
Height, cm (mean \pm SD)	1.32(0.096)	1.24(0.107)
CMI (mean \pm SD)	21.34 (2.80)	15.97 (1.68)

The BMI between the two study groups showed a significant difference ($p < 0.0001$). No correlations were found between the subclinical type of ADHD in either of the two study groups. By separating the population by the subclinical type of ADHD (Combined, Hyperactive-Impulsive and Combined), no significant differences were found with respect to BMI ($p = 0.12$). In the population of overweight infants, two subgroups were created; infants with obesity and without obesity, between these two

subgroups a significant difference was found in their BMI ($p < 0.001$), however, no correlation was found between the subclinical type and the BMI (correlation coefficients $p = 0.086$ and $p = -0.129$ respectively).

Subsequently, the population was analyzed by separating the overweight and overweight infants with respect to their gender and subclinical type. Using a Pearson's X² test, it was found that there is an association between the gender variable and clinical subtype ($p < 0.05$ in both genders) (Table 3).

TABLE 3. POPULATION DISTRIBUTION OF BOYS AND GIRLS WITH RESPECT TO OVERWEIGHT AND SUBCLINICAL TYPE.

Clinical subtype	Overweight n (%)		Not-Overweight n (%)	
	Men	Women	Men	Women
Combined	36 (63.79)*	13 (29.55)*	42 (44.68)*	42 (50.00)*
Inattention	12 (18.97)*	24 (54.55)*	20 (21.28)*	37 (44.05)*
Hyperactive-Impulsive	10 (17.24)*	7 (15.91)*	32 (34.04)*	5 (5.95)*

* $p < 0.05$, by X² of Pearson.

Likewise, in these subgroups a correlation was sought between the BMI and the clinical subtype, in no case could it be found. When comparing the BMI of each clinical subtype, a significant difference was found between the BMI of boys and girls with combined clinical subtype ($p = 0.004$).

Discussion

In recent years, TDHA and its comorbidity have become relevant; Such is the case between TDHA and the rates of overweight and obesity. Studies carried out in this area highlight the general information of groups of children and adolescents that describe the association between TDHA, obesity and overweight. Finally, the information is diluted by taking gender versus obesity and overweight as a variable. In the outstanding results of this study, when performing the gender analysis of the population of 280 infants diagnosed with ADHD, using a Pearson's X² test, it was found that there is an association between the gender variable and clinical subtype ($p < 0.05$) in both genders.

According to the National Resource Center for Children with ADHD and Adults with ADHD (CHADD) [17], there is little information that refers to ADHD in women due to the few studies conducted in this population. Most of the information we have about it is based on the clinical experience of mental health professionals who have specialized in treating adult women [18].

In the studies by Fliers E.A., (2013) [19], it showed in girls, ADHD seems to be a risk factor for overweight and also for obesity in children aged 10 to 12 years, in particular; in the

study he observed that 13% of boys and 15% of girls aged 10 to 12 in the general population of the Netherlands were overweight; Likewise, due to obesity, the numbers were even higher, with OR 1.39 in boys and OR 4.61 in girls.

Palazzo Nazar et al [20], compared the psychiatric comorbidity profile of obese women with ADHD. Where ADHD symptoms impact compulsive eating behaviors. The design was a cross-sectional study of a clinical sample of 171 adult women who were evaluated in a clinic specializing in obesity and erectile dysfunction. Obese patients with ADHD had a higher number of psychiatric comorbidities ($p < 0.001$), especially substance abuse disorders, and higher scores on the psychopathology rating scales ($p < 0.05$). The highest prediction for binge eating in the regression of symptoms of inattention and pulse-trait of ADHD. They conclude that ADHD should be routinely evaluated in more severe psychopathology. They also found symptoms of depression which can predict the presence of binge eating in obese patients.

A study by Shamah-Levy et al [21], describes obesity and overweight in Mexico in a child population where the objective was to update the prevalence of overweight and obesity (SP + O) and To study some associated determinants in population <20 years of age, from the National Mid-Way Health and Nutrition Survey 2016 [7], They studied sociodemographic variables associated with overweight through logistic regression. The national prevalence of SP + O in <5 years was 5.8% girls, 6.5% boys; school girls 32.8%, boys 33.7%; adolescents women 39.2% and men 33.5%. Teenage women from rural locations showed a 2012 to 2016 increase of 9.5 percentage points. The prevalence of SP + O in girls and women in rural areas shows a significant increase in a short period, which calls for immediate attention actions.

Other relevant data from the study conducted in the study group of children with ADHD, no correlations were found between the subclinical type of ADHD in either of the two study groups and also when separating the population by the subclinical type of ADHD (Combined, Hyperactive-Impulsive and Combined), no significant differences were found with respect to BMI ($p = 0.12$).

Among the studies that measure the prevalence of ADHD in obese subjects, we find the analysis carried out by Raquel Martínez de Velasco et al. [22], five studies conducted in clinical samples and two conducted with the general population. In the study, there was no higher prevalence of ADHD in patients with obesity, more symptoms of impulsivity, hyperactivity and attention deficit were described compared to controls in several tests. This lack of association could be due to the fact that the study focused on the association between obesity and impulsivity, did not use instruments specifically oriented to the search for ADHD, nor did it investigate this diagnosis as the main or categorical variable. ADHD is a disorder with three cardinal symptoms (attention deficit, impulsivity, hyperactivity), comorbid symptoms (depression, anxiety, addictions, sleep disorders, eating disorders ...) and typical psychosocial complications (conflictive relationships, demoralization, poor academic performance). Isolated or together these symptomatic groups have proven to be

obesity risk factors and converge in a common final path with other biological, psychological and social factors. This disorder can cause obesity or contribute greatly to its appearance, either because it is a disorder of executive function causes a disorganized lifestyle prone to food control, or because anxiety and depression secondary to ADHD lead the patient to use food as a substitute and anxiolytic satisfaction as in other eating disorders. Although compulsive intake is abundant in people with ADHD who are obese, binge eating is not a necessary or sufficient condition for ADHD and obesity.

Faraone, SV et al. [23], conducted studies where they examined BMI in a well-defined sample of children with a combined type of ADHD and the possible relationship with gender, age, severity of ADHD and comorbidity of psychiatric symptoms, as well as inhibitory control, developmental coordination disorder, short sleep and use of methylphenidate; He found that boys with ADHD have a general risk factor for overweight, especially from 10 years onwards.

One of the studies in the general population was conducted on a sample of 991 children (9-16 years old) and found no association between ADHD and Obesity [24].

In another study, specific screening instruments were used and then structured psychiatric interviews in an initial sample of 34,653 adults from the NESARC (National Epidemiologic Survey on Alcohol and Related Conditions), the objective was to measure the association between the obese condition and the diagnosis of ADHD (in adulthood and in retrospect) controlling variables such as socioeconomic status, humor, anxiety and substance use disorder. He concluded that ADHD detected in adults was not associated with obesity when confounding factors were controlled, but having had ADHD symptoms in childhood was associated with obesity in adult women. This provides a basis for future longitudinal studies that assess the effect of treating ADHD during childhood on the weight of adult women [25].

Conclusions

The results of this study show us the need for the analysis and investigation of the population that presents ADHD, subclinical type and the association with overweight emphasizing gender, in the studies carried out, the findings show us that there is the possibility of a correlation between these variables. Our results of the gender analysis of the population of 280 infants diagnosed with ADHD, show the existence of an association between the gender variable and clinical subtype. It is important to continue with these studies to have more data by gender in children.

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