



HEPATIC STEATOSIS IN SCHOOLCHILDREN AND ADOLESCENTS WITH CENTRAL OBESITY

ESTEATOSIS HEPATICA EN ESCOLARES Y ADOLESCENTES CON OBESIDAD CENTRAL

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ABSTRACT

Introduction: Non-alcoholic hepatic steatosis is defined as the excessive accumulation of adipose tissue in the absence of alcohol consumption, being rare in the pediatric population. However, with the advent of the twentieth century pandemic, such as obesity, this pathology has increased its incidence, as well as others that belong to the metabolic syndrome. **Objective:** To determine the presence of hepatic steatosis in schoolchildren and adolescents with central obesity. **Methods:** observational, descriptive and cross-sectional research. The sample was of a census type, represented by 32 schoolchildren and adolescents who met the inclusion criteria, which are: age between 6 and 19 with central obesity - prior signing the informed consent. They underwent measurement of the waist circumference, abdominal ultrasound, measurement of the lipid profile and the determination of the level of physical activity

through the application of the Pictorial Questionnaire of Infant Physical Activity. Results: 32 patients were studied, 18 (56.3%) male, adolescents 59.37%. With normal ultrasound (29/32) and with hepatic steatosis (3/32), of which 66.7% are grade II and 33.3% are grade III. Hypertriglyceridemia and borderline triglyceride levels 81.27% and hypercholesterolemia and borderline cholesterol levels 75%. **Conclusion:** School and adolescent patients with central obesity have borderline lipid profiles or dyslipidemia, in which, despite belonging to the pediatric population, moderate and severe cases of hepatic steatosis are evident.

Keywords: fatty liver, non-alcoholic fatty liver disease, dyslipidemia, obesity.

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INTRODUCTION

Nonalcoholic steatohepatitis (NASH), also known as Nonalcoholic fatty liver disease (NAFLD), is defined as the excessive accumulation of adipose tissue, in the absence of alcohol consumption due to an imbalance between the hepatic synthesis of triacylglycerides (TAG) and very low-density lipoprotein (VLDL) secretion. It is associated with multiple metabolic comorbidities, such as dyslipidemias, insulin resistance, and obesity. The latter being the most important (1-6). It should be noted that hepatic steatosis is a disease that is not very common in pediatrics. However, in recent years it has probably become the most common cause of chronic liver disease in children and young people, primarily related to the obesity epidemic. It is estimated that the prevalence of pediatric hepatic steatosis ranges between 3-10% (7-11).

This wide prevalence interval is influenced by the diagnostic method used to detect hepatic steatosis, such as liver histology, which is the gold standard method for diagnosing this pathology. However, non-invasive tests are normally used in the pediatric population, such as waist circumference

measurement, observation of slight increase in lipid values, as well as a bright image of the liver on abdominal ultrasound (12-16). Its pathophysiological mechanisms are not yet fully known. But it has been observed that in overweight children and adolescents they tend to increase, with at least 50% of them presenting some degree of hepatic steatosis. In the European continent, it is estimated that the incidence of non-alcoholic hepatic steatosis is 25%, in the United States it is estimated 10-20% in the pediatric population and 34% in adults, in Asia the rates incidence are around 30%. The development of hepatic steatosis is influenced by ethnicity, gender and age, being twice more common in boys than in girls. Hepatic steatosis can progress to end-stage liver pathologies, such as liver cirrhosis and / or hepatocellular carcinoma (17-21).

During the last decades, the incidence of childhood obesity has been increasing considerably around the world, as mentioned in various studies in several developed countries. Childhood obesity is calculated based on the body mass index (BMI), but it is considered as an indirect marker of risk of metabolic syndrome since it does not reflect the percentage or distribution of body fat. On the other hand, central obesity is precisely the

one that has greater clinical significance for cardiovascular disease, especially visceral fat (22-25).

According to the World Health Organization (WHO), worldwide obesity since 1975 has almost tripled. Thus, it was estimated that 41 million children under 5 years of age and 340 million children and adolescents between 5 and 19 years of age were overweight or obese in 2016. Meanwhile, in Spain, in the population of 2 to 19 years of age, this has an important place since it has an incidence of obesity of 7.5-10%, surpassing the rest of European countries such as: Germany, Belgium, England or France. However, according to the criteria established by the WHO, in this population group, the incidence of severe obesity is 4% (26-30).

In recent years, the importance of the distribution of body fat more than the amount of total body fat has been focused. It has been proven that excess visceral fat establishes an important predictor of cardiovascular and metabolic risk in children and adolescents. Currently, the anthropometric variable that is mostly used to determine abdominal fat is waist circumference (WC), which additionally has a low measurement error, and simple and inexpensive equipment is used. For its analysis, the percentiles are mainly used instead of the absolute values to compensate for the variations in child development and ethnic origin, for which different countries have developed curves and tables of waist circumference percentiles for the child population (31-36). According to the Center for Disease Control and Prevention (CDC), American schoolchildren and adolescents have an incidence of obesity of 30%, indicating similar data in South American countries, such as Ecuador (37-40). Obesity is considered as the result of low levels of physical activity and trends towards sedentary lifestyles, the latter increases with age for both sexes. It is encouraged the challenge for the scientific community to incorporate valid and reliable measurements that allow constant health surveillance. In the same way, possible patterns and causes that can detect chronic pathologies can be established (41).

There are few studies about this pathology in the child population in the Ecuadorian highland region. Therefore, this has motivated this research, as well as the need for up-to-date and in-depth information.

OBJECTIVE

To determine the presence of hepatic steatosis in schoolchildren and adolescents with central obesity

METHODS

The research was carried out in the city of Ambato, in a period between April-July 2021. The study design is quantitative, descriptive and cross-sectional. The sample was of a census type (42) represented by 32 schoolchildren and adolescents who met the inclusion criteria, which are: schoolchildren and adolescents with an age between 6 and 19 with central obesity, prior to informed consent based on the Helsinki Code and respecting the principle of autonomy of each participant, who could leave it at any point (43,44). As for the exclusion criteria: schoolchildren and adolescents without central obesity, those who did not sign the informed consent and those previously diagnosed with liver disease.

The patients underwent the measurement of the waist circumference for the classification of central obesity, since it constitutes one of the inclusion criteria. Likewise an abdominal ultrasound was performed; serum samples were taken to determine the profile values lipid, which are: total cholesterol, HDLc, LDLc and triglycerides. In addition, the physical activity of schoolchildren and adolescents was evaluated. All these aspects were evaluated in a single meeting with each patient.

Measurement of waist circumference and determination of central obesity

In the measurement of the waist circumference, the non-extendable anthropometric tape brand cescorf® was used, with a measurement range of 0 to 200 cm and measurement start at 10 cm from the tip, corresponding to number 1. With the patient standing, with a bare abdomen and the arms on each side, the lower point of both the right and left costal ridge and both iliac crests was identified. A mark was drawn with a pen and the midpoint between the two marks was found with the measuring tape, and this was identified with another color. With the examiner behind the patient, the measuring tape was passed around the body at the indicated point horizontally, making the measurement at the exact moment of expiration, using it in centimeters and writing down the result. Once the waist circumference of the schoolchildren and adolescents had been identified, they were placed in a table according to their age and sex, managing to classify them according to the existing 3, 10, 25, 50, 75, 90 and 97 percentiles. Central Obesity was considered to those schoolchildren and adolescents with percentiles above 90 using Table 1, validated in Vargas' study (22) according to sex and age, based on Fernandez's study (45).

TABLE 1
WAIST CIRCUMFERENCE PERCENTILE (WCP) BY AGE AND GENDER IN
CHILDREN AND ADOLESCENTS

Male								
Age	N	Percentiles						
		3	10	25	50	75	90	97
2	25	43,5	45,0	46,5	48,5	51,0	54,5	58,5
3	22	44,5	46,0	48,0	50,0	53,0	56,5	61,5
4	84	45,0	47,0	49,0	51,5	54,5	59,0	65,0
5	91	46,0	48,0	50,5	53,0	56,5	62,5	68,5
6	71	46,5	49,5	51,5	54,5	59,0	64,5	73,5
7	55	47,5	50,0	52,5	56,0	61,0	67,5	78,5
8	68	48,5	51,5	54,0	58,5	63,5	72,5	84,5
9	71	50,0	52,5	56,5	61,0	67,0	76,0	92,0
10	81	51,5	54,5	58,5	64,0	71,0	81,5	99,5
11	76	53,0	56,5	61,0	67,0	74,5	86,0	106,5
12	65	54,5	58,5	63,5	70,0	78,5	91,0	112,5
13	57	56,0	60,0	65,5	72,5	81,0	95,0	118,0
14	39	57,5	62,0	67,5	74,5	84,0	99,0	123,0
15	31	59,0	63,5	69,0	76,5	87,0	102,5	128,5
16	29	60,0	65,0	71,0	78,5	89,5	106,0	133,5
17 a 18	19	61,0	66,5	73,0	81,0	92,5	109,5	139,0

Female								
2	36	43,0	44,0	46,0	48,0	51,0	54,5	59,5
3	22	44,0	46,0	48,0	50,0	53,0	57,0	62,5
4	66	45,0	47,0	49,0	51,5	55,0	59,5	65,0
5	108	45,5	47,5	50,0	53,0	56,5	61,5	67,5
6	70	46,0	48,0	51,0	54,0	58,0	64,5	71,0
7	56	46,0	49,0	52,5	55,0	60,0	66,0	74,5
8	73	47,0	49,5	53,0	57,0	62,5	69,0	77,5
9	70	47,5	51,0	54,5	59,5	64,5	72,5	82,5
10	93	49,0	52,5	56,5	62,0	68,5	76,5	87,5
11	90	50,0	54,5	59,0	65,0	72,0	81,0	93,0
12	53	52,0	56,0	61,0	67,5	75,0	85,5	98,0
13	44	53,0	57,5	63,0	69,5	78,0	88,5	102,5
14	34	54,0	59,0	64,5	71,5	80,5	91,5	106,0
15	29	55,0	60,0	66,0	73,5	82,5	94,5	110,0
16	31	55,5	61,0	67,0	74,5	84,0	96,5	114,5
17 a 18	28	56,5	62,0	68,5	76,0	86,0	99,0	117,0

Source (22)

Detection of hepatic steatosis by abdominal ultrasound

To determine the presence of hepatic steatosis, an abdominal ultrasound was performed with the Chison Cbit 8 equipment with a 3.5 Mhz convex transducer. And depending on the characteristics of each patient, the gain and focal zone parameters were adjusted. This was performed by a specialized doctor in diagnostic imaging. The degree of hepatic steatosis was determined as: grade I or mild, minimal diffuse increase in liver echogenicity with clear visualization of the diaphragm and the wall of the intrahepatic vessels. Grade II or moderate, moderately diffuse increase in echogenicity of the liver with slightly decreased visualization of the diaphragm and intrahepatic vessel walls. And grade III or severe, with significant increase in echogenicity of the liver with little or no visualization of the diaphragm and hepatic vessels (15)

Measurement of the lipid profile and classification according to reference values

To measure the lipid profile, venous blood samples were taken from each participant using appropriate biosafety measures required by the laboratory. Reagents were used to determine Triglycerides, Total Cholesterol, HDLc by means of the enzymatic colorimetric method. For LDLc the Friedewald formula was applied: $LDLc = Total\ cholesterol - HDLc - (TG / 5)$

For the analysis of the results, the reference values expressed in Table 2 were used, which were applied by Gambetta in his study and based on the 2011 Expert Panel on Risk Reduction and the integrated guidelines for cardiovascular health in children and adolescents from the National Heart Institute. This allows classifying each of the lipid profile parameters as acceptable, limit and high. It was managed to observe alterations in these values, which may be related to the development of pathologies, and within these, hepatic steatosis (46)

TABLE 2
REFERENCE VALUES OF LIPIDS AND LIPOPROTEINS IN CHILDREN AND ADOLESCENTS

Parameter	Acceptable (mg/dl)	Limit (mg/dl)	High (mg/dl)
Triglycerides			
0-9 years old	<75	75-99	≥ 100
10-19 years old	<90	90-129	≥ 130
Total Cholesterol	<170	170-199	≥200
LDLc	<110	110-129	≥130
HDLc	>45	40-45	<40

C: cholesterol; HDLc: high density lipoprotein cholesterol; LDLc: low density lipoprotein cholesterol (46)

Determination of the level of physical activity

To determine the level of physical activity, the Pictorial Questionnaire of Infant Physical Activity was used. It is validated by experts and consists of 7 items, with multiple-choice alternatives, which were formulated virtually by Microsoft Forms software, allowing to measure the level of physical activity in children and adolescents during the last 7 days at different times of the day (for example: at school, in physical education, recess, after school, at night and on the weekend).

The scoring range for each question is from 1 to 4. This is 1 point for the sedentary image, 2 points for the low-active image, 3 points for the active image, and 4 points for the very active image. Using the arithmetic mean of the scores obtained in the first 5 questions the final score of the physical activity questionnaire is obtained. Since the closer the value is to 4, the more active the person is and the closer to the value 1, the more it tends to be sedentary (41).

The data analysis was used in the statistical software SPSS version 26 of 2019. For the qualitative variables, a frequency analysis is presented. As for the quantitative variables,

measures of central tendency and dispersion were studied; to measure the relationship between the variables, the chi square test in contingency tables or cross tables were used.

Ethics

Regarding ethical considerations, the research participants delivered their informed consent, and their information is safeguarded under the ethical principles established in the Declaration of Helsinki. It commits the researcher to the protection of dignity, autonomy, privacy and confidentiality of the data of the population under study.

RESULTS

32 patients with central obesity were analyzed, of which 18 (56.25%) were males and 14 (43.75%) were females, aged between 6 and 19, with adolescents representing 59.37 %. The absence of hepatic steatosis in schoolchildren and adolescents with central obesity prevailed markedly. Nevertheless, its presence was found in 3/32, with 2/32 (66.67%) of the male sex and of the adolescent group; and 1/32 (33.33%) of the female sex of the group of schoolchildren (Table 3).

TABLE 3
DISTRIBUTION OF LIVER STEATOSIS IN SCHOOLCHILDREN AND
ADOLESCENTS WITH CENTRAL OBESITY ACCORDING TO SEX AND AGE

Variable	Liver steatosis			
	Present	Absent	Total	
	N° (%)	N° (%)	N° (%)	
Sex	Male	2 66,67%	16 55,17%	18 56,25%
	Female	1 33,33%	13 44,83%	14 43,75%
Age group (years)	From 10 to 19	2 66,67%	17 58,62%	19 59,37%
	From 6 to 9	1 33,33%	12 41,38%	13 40,63%

With the presence of hepatic steatosis (3/32) in schoolchildren and adolescents with central obesity, there is a higher frequency of grade II 66.7% (2/32), followed by grade III 33.3% (1/32), and the absence of hepatic steatosis, that is normal ultrasound, predominated with (29/32) (Table 4)

TABLE 4
DISTRIBUTION OF HEPATIC STEATOSIS IN SCHOOLCHILDREN AND ADOLESCENTS WITH
CENTRAL OBESITY ACCORDING TO GRADING

		Hepatic steatosis grading			No steatosis	Total
		Hepatic Steatosis Grade II	Hepatic Steatosis Grade III	Normal Ultrasound		
		Present	Frequency	2	1	
Hepatic Steatosis		%	66,7%*	33,3%	0,0%	100,0%
	Absent	Frequency	0	0	29	29
		%	0,0%	0,0%	100,0%	100,0%

Regarding the presence of hepatic steatosis in schoolchildren and adolescents with central obesity and the different components of the lipid profile, it was possible to show that they present hypertriglyceridemia and borderline triglyceride levels (26/33), representing 81.27%, from which 3 individuals have hepatic steatosis. Hypercholesterolemia and borderline cholesterol levels (24/33) corresponding to 75%. On the other

hand, there is high-density hyperlipoproteinemia and borderline HDLc levels in (17/33) with 53.13% being found in the 3 patients with hepatic steatosis. In addition, there is the presence of low-density hyperlipoproteinemia and borderline LDLc levels in (20/33), which is expressed by 62.51% of individuals (Table 5).

TABLE 5
DISTRIBUTION OF HEPATIC STEATOSIS IN SCHOOLCHILDREN AND
ADOLESCENTS WITH CENTRAL OBESITY AND THE COMPONENTS OF THE LIPID
PROFILE

Variable		Hepatic Steatosis		
		Present	Absent	Total
		N° (%)	N° (%)	N° (%)
Triglycerides	Acceptable	0 0,00%	6 20,69%	6 18,75%
	High	2 66,667%	13 44,828%	15 46,875%
	Limit	1 33,3%	10 34,5%	11 34,4%
		3 100,00%	5 17,24%	8 25,00%
Cholesterol	Acceptable	0 0,00%	10 34,48%	10 31,25%
	High	0 0,00%	14 48,28%	14 43,75%
	Limit	0 0,00%	15 51,72%	15 46,88%
HDL	Acceptable	2 66,67%	11 37,93%	13 40,63%
	Low	1 33,33%	3 10,34%	4 12,50%
	Limit	2 66,67%	10 34,48%	12 37,50%
LDL	Acceptable	0 0,00%	7 24,14%	7 21,88%
	High	1 33,33%	12 41,38%	13 40,63%
	Limit			

Regarding the level of physical activity of schoolchildren and adolescents, an absolute absence of sedentary lifestyle is observed according to sex. However, in the not-very-active class, 62.50% are male and 53.33% are active, while the female sex presents values 37.50% and 46.67% respectively. In relation to the classification of very active, only 1 individual of the female sex was observed, prevailing over the male.

According to the distribution by age groups, from 10 to 19 years old, the not-very-active classification represents 68.75% and the active group 53.33%. The 6 to 9-year-old group reflects 31.25% and 46.67% respectively, while only one individual at this age is presented as very active (table 6).

TABLE 6
DISTRIBUTION OF PHYSICAL ACTIVITY OF SCHOOLCHILDREN AND ADOLESCENTS WITH
CENTRAL OBESITY ACCORDING TO SEX AND AGE

Variable	PHYSICAL ACTIVITY					Total N° (%)
	Sedentary lifestyle	A little active	Active	Very active		
	N° (%)	N° (%)	N° (%)	N° (%)		
Sex	Male	0 0,00%	10 62,50%	8 53,33%	0 0,00%	18 56,25%
	Female	0 0,00%	6 37,50%	7 46,67%	1 100,00%	14 43,75%
Age group (years)	From 6 to 9	0 0,00%	5 31,25%	7 46,67%	1 100,00%	13 40,63%
	From 10 to 19	0 0,00%	11 68,75%	8 53,33%	0 0,00%	19 59,38%

Pictorial Questionnaire of Children's Physical Activity (41)

DISCUSSION

Early-onset hepatic steatosis in pediatric ages must be managed with special attention, due to the silent and potentially lethal course. Its clinical manifestations are scarce and allow its progression. But they can be prevented, reducing the degree of hepatic infiltration through weight loss and lifestyle change.

In this series of cases, the frequency of hepatic steatosis was lower than that reported by Gambetta et al. who diagnosed it, by ultrasound, in 42.9% of 77 patients aged 2 to 13 years and 11 months. These authors attributed this increase in frequency to the fact that the patients who were referred by the pediatric endocrinology service were diagnosed with obesity (46).

Similarly, Gonzales et al., obtained a prevalence of hepatic steatosis diagnosed by ultrasound of 28.3% of 46 patients aged between 2 and 18 years with obesity, being predominantly males, who attended the outpatient consultation of endocrinology of the Regional General Hospital (7). On the other hand, Arza et al, obtained a 36% prevalence of hepatic steatosis in children aged 5 to 14 years with overweight and obesity who attended obesity consultation of family medicine. In the same way, an elevated level of triglycerides was obtained in patients with steatosis liver (14).

For Bejarano, the percentage was higher in the prevalence of hepatic steatosis with 65% according to ultrasound with an age range of 4 to 14, with altered lipid profile and liver function tests such as: elevated cholesterol in 67% , triglycerides 97% transaminases and alkaline phosphatase in 35%, and elevated glycemia in 4%. The normal values for the age of each patient were considered (8).

Abdominal ultrasound is considered a good method to diagnose and control the degree of fat infiltration in the liver since it has specificity, sensitivity, positive and negative predictive value. Different studies have investigated the use of magnetic resonance imaging and computed tomography to diagnose hepatic steatosis. These tests have a high cost and additionally require sedation of the child (46).

The current study is about schoolchildren and adolescents with central obesity who perform little physical activity. Therefore it is necessary to make changes in their lifestyle, they require multidisciplinary management with the participation of nutrition, preventive medicine and a physician. It must be remembered that weight loss is essential. Real goals must be established in the short and long term. Moreover, the education of parents, patients and teachers is very fundamental to obtain success in treatment. Currently, there is only consensus on treatment through physical exercise and diet with proven efficacy. However, both measures are difficult to maintain in the pediatric age, which makes it necessary to search for new therapeutic targets (47).

CONCLUSION

School and adolescent patients with central obesity present borderline lipid profiles or dyslipidemia, in which, despite belonging to the pediatric population, there are moderate and severe cases of hepatic steatosis.

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