ORIGINAL ARTICLE

Prevalence of non-alcoholic fatty liver disease in overweight or obese adolescents

Herminia Lázaro Rodríguez[1,2], Mareyke Medina-Huayta[1,3], Martina Huamán Rodríguez[1,3], Gabriela Lucía Rodríguez Lázaro[4], Maykoll Cristhian Campos Rodríguez[1]

[1] Facultad de Medicina, Universidad Nacional de Trujillo, Trujillo, Perú
[2] Doctor en Medicina
[3] Magister en Investigación Clínica
[4] Hospital Víctor Lazarte Echegaray, Trujillo, Perú

ABSTRACT

This study aimed to determine the prevalence of non-alcoholic fatty liver disease in overweight and obese adolescents in a high school in Trujillo in 2023. A descriptive, cross-sectional study was conducted, including adolescents of both sexes, aged 12 to 14 years, with excess weight. Those with chronic diseases or undergoing pharmacological treatment with hepatotoxic effects were excluded. Validated methods for anthropometric measurement and ultrasound evaluation were used. Out of 130 adolescents with excess weight, 23 were diagnosed with obesity. This includes 14 males (60.8 %) and 9 females (39.2 %), all of whom underwent a liver ultrasound. Out of the adolescents evaluated, 34.8 % had nonalcoholic fatty liver disease. These findings show that approximately one-third of adolescents with obesity had an ultrasound-confirmed diagnosis of non-alcoholic fatty liver disease. This highlights the importance of designing and implementing educational strategies to promote healthy eating and physical activity, both in adolescents and their caregivers, particularly for those diagnosed with non-alcoholic fatty liver disease.

Keywords: Child; Adolescent; Obesity; Overweight; Non-alcoholic Fatty Liver Disease (Source: MeSH)

Prevalencia de hígado graso no alcohólico en adolescentes con sobrepeso y obesidad

RESUMEN

El objetivo del estudio fue determinar la prevalencia de hígado graso no alcohólico en adolescentes con sobrepeso y obesidad en un colegio secundario de Trujillo en 2023. Se realizó un estudio descriptivo y transversal, incluyendo adolescentes de ambos sexos, de entre 12 y 14 años, con exceso de peso. Se excluyeron aquellos con enfermedades crónicas o tratamiento farmacológico con efecto hepatotóxico. Se emplearon métodos validados para la medición antropométrica y la evaluación ecográfica. De los 130 adolescentes con exceso de peso, 23 fueron diagnosticados con obesidad; 14 (60,8 %) varones y 9 (39,2 %) mujeres, y se les realizó ecografía hepática. El 34,8 % de los adolescentes evaluados presentaron hígado graso no alcohólico. Los resultados muestran que aproximadamente un tercio de los adolescentes con obesidad presentaron diagnóstico ecográfico de hígado graso no alcohólico, lo que resalta la importancia de diseñar e implementar estrategias educativas para promover una alimentación saludable y la actividad física, tanto en los adolescentes como en sus cuidadores, especialmente en aquellos con diagnóstico de hígado graso no alcohólico.

Palabras clave: Niño; Adolescente; Obesidad; Sobrepeso; Enfermedad del Hígado Graso no Alcohólico (Fuente: DeCS)

INTRODUCTION

A significant number of children in low- and middle-income countries are grappling with altered nutritional status, including stunted growth, micronutrient deficiencies, and excess weight. These conditions, often a result of environmental changes and lifestyle factors, can coexist within a single family or individual (1,2). The global prevalence of overweight among children under 5 years of age has increased from 4.9% to 5.9%, and among children aged 5

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Corresponding author:
Mareyke Natividad Medina Huayta
Address: Calle Turmalinas 913, Trujillo, La Libertad, Perú
Phone: +51 959907032
E-mail: mareyke@gmail.com

ORCID iDs
Herminia Lázaro Rodríguez
https://orcid.org/0000-0002-5000-5446
Mareyke Medina-Huayta
https://orcid.org/0000-0002-3096-5212
Martina Huamán Rodríguez
https://orcid.org/0000-0003-0073-0014
Gabriela Lucía Rodríguez Lázaro
https://orcid.org/0009-0004-5226-6377
Maykoll Cristhian Campos Rodríguez
https://orcid.org/0009-0000-2602-0171

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to 19 years, from 10.3% to 18.4%. In Latin America and the Caribbean, these statistics are even higher: in preschoolers, the prevalence increased from 6.6% to 7.5%; in children aged 5 to 9 years, from 23.7% to 33.5%; and in adolescents, from 20.4% to 29%. Obese preschoolers are five times more likely to become overweight adolescents, and 70% of obese adolescents and 40% of obese schoolchildren will remain obese into adulthood (2). In Peru, in 2020, 27% of children aged 5 to 19 years were reported to be overweight (3).

Excess weight is defined as an abnormal or excessive accumulation of fat. In children aged 5 to 19 years, excess weight is assessed using the body mass index (BMI)-for-age; for children under 5 years, it is assessed using weight-for-height (1). A diet unbalanced in macro- and micronutrients can lead to excess weight and, in its most severe form, obesity, which can result in detrimental health effects such as poor cognitive performance, disruptive behavior, and low self-esteem, thereby hindering social integration. In the long term, obesity increases the risk of developing musculoskeletal disorders, sleep apnea, cardiovascular disease, glucose intolerance, type 2 diabetes, and non-alcoholic fatty liver disease (NAFLD) (4). NAFLD is defined as fat accumulation in more than 5% of hepatocytes in the absence of liver diseases caused by viruses, autoimmune or metabolic conditions, or associated with drug use or alcohol consumption. In non-alcoholic steatohepatitis, inflammatory histopathological changes or fibrosis are observed. Its progression may range from simple steatosis to liver cirrhosis and hepatocellular carcinoma (5,6).

The prevalence of NAFLD has been rising, affecting children from early ages; however, it is more common in adolescents, possibly due to the influence of sex hormones and insulin resistance during puberty, and is more prevalent in males, with a male-to-female ratio of 2:1 (7,8). Some studies report a global prevalence of 24%, with 21.6% among overweight children and up to 50.8% in obese children (9). A study in the United States showed an increase in NAFLD among children aged 9 to 18 years, from 36 cases per 100,000 in 2009 to 58.2 per 100,000 in 2018 (10).

Liver biopsy is the reference standard for diagnosis; however, due to its invasive nature, it is not always feasible. Imaging studies, such as ultrasound, are more relevant due to their safety, low cost, and reliability, and are the most widely used method. The sensitivity of ultrasound to detect hepatic steatosis ranges from 60% to 94% and specificity from 84% to 95%. The calculation of the hepatorenal index improves sensitivity to 100% and specificity to 91% for detecting steatosis above 5% (11). Regarding biomarkers, liver enzymes such as alanine aminotransferase (ALT) have optimal cutoff points of 42 U/L for boys and 30 U/L for girls (12,13). A histological post-mortem liver study found steatosis in 9% of children and inflammation or fibrosis in 3%, concluding that NAFLD could affect up to 10% of individuals under 18 years old, with prevalence varying by race and ethnicity (Hispanic 11.8%, Asian 10.2%, White 8.6%, Black 1.5%), and increasing to 38% among obese children. Prevalence also increases with age, from 0.7% in children aged 2 to 4 years to 17.3% in adolescents aged 15 to 19 years (14).

Given that fatty liver disease can progress to severe liver disease and cirrhosis, early detection and treatment are essential. According to clinical practice guidelines, screening for NAFLD is recommended between the ages of 9 and 11 years in obese children and in overweight children who present additional risk factors such as central adiposity, insulin resistance, prediabetes or diabetes, dyslipidemia, sleep apnea, or a family history of NAFLD (15). This underscores the importance of our study, which aims to determine the prevalence of NAFLD in overweight and obese adolescents from a secondary school in the city of Trujillo in 2023.

Early detection of NAFLD in overweight and obese children is not only crucial for their long-term health benefits but also for potential cost savings in diagnosis and treatment. This study aimed to determine the prevalence of NAFLD in overweight and obese adolescents from a secondary school in the city of Trujillo in 2023.

METHODS

Study design

This study utilized a descriptive, cross-sectional design and was conducted at a secondary school in Trujillo, La Libertad, Peru, in 2023.

Population and sample

The study population consisted of adolescents of both sexes, aged 12 to 14 years, enrolled in the first and second years of secondary school, with an anthropometric diagnosis of overweight or obesity. Exclusion criteria included chronic conditions such as congenital heart disease, diabetes, nephropathies, musculoskeletal disorders, or a history of pharmacological treatment with hepatotoxic effects. Since all adolescents within the specified age range were included upon parental authorization, no sample size calculation was performed.

Study variables

The variables considered were sex, weight, height, height-for-age, BMI-for-age, nutritional status, and hepatic steatosis. BMI was calculated by dividing weight in kilograms by the square of height in meters. Hepatic steatosis was defined as the presence of fat infiltration greater than 5%, as detected by hepatic ultrasound. All variables were entered into a database prepared for subsequent analysis.

Procedures

Anthropometric assessment: Weight and height measurements were taken from all adolescents aged 12 to 14 years at the selected school after obtaining their assent and in coordination with the school staff. Weight was measured while wearing light clothing (shorts, t-shirt, and socks) using a Citizen HMS324 digital scale with a capacity of up to 120 kg. Height was measured in a standing position using a metal stadiometer graduated in centimeters and millimeters, following World Health Organization (WHO) recommendations. These measurements were used to

calculate BMI-for-age (Quetelet index) and height-for-age indicators.

Nutritional diagnosis: Nutritional status was determined according to WHO growth charts for BMI-for-age by sex. Classifications were as follows: at risk of underweight between -1 and -2 standard deviations (SD), normal between +1 and -1 SD, overweight between +1 and +2 SD, obesity between +2 and +3 SD, and severe obesity above +3 SD. Height-for-age was also classified according to WHO standards by sex: short stature below -2 SD, at risk of short stature between -1 and -2 SD, normal height between -1 and +2 SD, and tall stature above +2 SD.

Ultrasound evaluation: A certified radiologist performed liver ultrasounds on the adolescents who met the inclusion criteria and agreed to the procedure. A portable Butterfly IQ+ Probe ultrasound device in abdominal mode was used. Hepatic steatosis was recorded as a qualitative variable (present or absent) based on the presence of fat infiltration greater than 5%. The results were communicated to the parents or guardians by telephone.

Statistical analysis

The variables, sex, nutritional classification by BMI-for-age, height-for-age, and hepatic steatosis, were reported as frequencies and percentages. Mean, standard deviation and minimum and maximum values were calculated for age, weight, height, BMI, and liver height.

Ethical considerations

The research protocol was reviewed and approved by the Research Unit and Ethics Committee of the National University of Trujillo. Parental consent and adolescent assent were obtained for study participation. Patient data were handled with strict confidentiality, and participants were identified using codes assigned by the research team.

RESULTS

An anthropometric assessment was conducted on 257 students, of whom 130 (50.6%) were found to be overweight. Among these 130 students, 80 (61.5%) were classified as overweight, 48 (36.9%) as obese, and 2 (1.5%) as severely obese, one female and one male (Table 1).

Among the 130 students with excess weight, a liver ultrasound was performed on 23 students with a diagnosis of obesity. Of the students evaluated, 14 (60.8%) were male and 9 (39.2%) female, with a mean age of 13.57 years (±0.81). The minimum weight was 58.1 kg, and the maximum was 98.1 kg. The mean BMI was 2.42 (±0.34), consistent with obesity, and the highest BMI value was 3.26, corresponding to severe obesity in a female student. The mean liver height was 133.09 mm (±8.26) (Table 2).

Non-alcoholic fatty liver disease was present in 34.8% of the students evaluated, with a prevalence of 50% among males and 11% among females (Table 3). According to the ultrasound reports, all cases of hepatic steatosis were classified as mild.

Table 1. Characteristics of adolescents aged 12 to 14 years enrolled in a secondary school in Trujillo, 2023 (n = 257)

Characteristics	n	%
Sex		
Female	112	43.6
Male	145	56.4
Nutritional status [a]		
Extreme obesity	2	0.8
Obesity	48	18.7
Overweight	80	31.1
Normal	116	45.1
At risk of underweight	9	3.5
Underweight	2	0.8
Height-for-age [b]		
Tall	24	9.3
Normal	169	65.8
At risk of short stature	54	21.0
Short stature	10	3.9

[a] *Based on WHO Tables for BMI-for-age by sex*
[b] *Based on WHO Tables for height-for-age by sex*

Table 2. Characteristics of adolescents aged 12 to 14 years classified as obese based on anthropometric assessment and ultrasound evaluation, Trujillo, 2023 (n = 23)

Characteristics	Mean (SD)	Minimum	Maximum
Age (years)	13.57 (0.81)	12.1	14.7
Weight (kg)	71.06 (10.33)	58.1	98.1
Height (cm)	158.39 (7.51)	145.9	176.5
BMI	2.42 (0.34)	2	3.26
Liver height (mm)	133.09 (8.26)	113	149

SD: standard deviation

Table 3. Non-alcoholic fatty liver disease by sex among adolescents aged 12 to 14 years with obesity enrolled in a secondary school in Trujillo, 2023 (n = 23)

Non-alcoholic fatty liver disease	Male	Female	Total
	n (%)	n (%)	n (%)
Yes	7 (50.0)	1 (11.1)	8 (34.8)
No	7 (50.0)	8 (88.9)	15 (65.2)
Total	14 (100.0)	9 (100.0)	23 (100.0)

DISCUSSION

Childhood obesity is a risk factor for NAFLD in pediatrics, and although liver biopsy is the gold standard for diagnosis, its invasive nature makes liver ultrasound a valuable alternative (16). In this study, the prevalence of NAFLD diagnosed by ultrasound was 34.8% among adolescents aged 12 to 14 years in a school in Trujillo. This finding is consistent with previous studies, such as that by León-Plascencia et al. (17), who reported a prevalence of 39.4% in Mexican children. Pontiles et al. (18) found that 38.8% of obese Venezuelan children had both fatty liver and fatty pancreas, 27.1% had fatty liver alone, and 7.1% had only fatty pancreas. Anderson et al. (19) conducted a systematic review in 2015, reporting a mean prevalence of 7.6% for NAFLD among children aged 1 to 19 years, increasing to 34.2% among those treated in pediatric obesity specialty centers. Furthermore, the prevalence of NAFLD in obese children and adolescents was lower when alanine aminotransferase (ALT) was used as the diagnostic tool, compared to liver biopsies, ultrasounds, or MRI (19).

Conversely, a 2021 study by García-López (20) on Mexican children who were overweight and obese reported that 11% had some degree of the fatty liver based on AST levels and ultrasound findings. This percentage is much lower than that reported by Pontiles et al. (18) and Anderson et al. (19). In contrast, Jiménez-Rivera et al. (16) reported that up to 70% of obese children had some degree of fat infiltration detected by ultrasound. These findings differ from those found in our study.

NAFLD prevalence values in pediatrics vary across studies, as demonstrated by the systematic review by Anderson et al. (19), which highlighted considerable heterogeneity among studies ($I^2 = 98\%$). According to the study by León-Plascencia et al. (17), most children aged 6 to 16 years with NAFLD were female (57.6%). Other authors suggest there is no significant sex-based difference in NAFLD prevalence (11, 12, 13). These findings contrast with our results, where 50% of male participants had NAFLD compared to 11% of females. This difference may be explained by the influence of sex hormones in the evaluated age group, such as the mediating role of testosterone in the development of fatty liver and the protective effect of estrogen (21). In contrast, the other studies reported data across a broader age range, including both school-aged children and adolescents. Although Anderson et al. (19) found no significant difference in NAFLD prevalence by sex, they recommended that future studies report prevalence by sex separately.

The findings of this study suggest that the number of obese adolescents with NAFLD in our setting could be significant and may represent a public health concern that requires a comprehensive approach to promote early interventions aimed at preventing disease progression. NAFLD prevalence in pediatrics varies among studies due to methodological heterogeneity and differences in study population characteristics. Therefore, it is essential to continue research in this field and to analyze the genetic, socio-environmental, and cultural factors involved.

One of the study's limitations was the small number of overweight adolescents evaluated by ultrasound due to multiple factors, particularly fear of the procedure. The limited sample size may restrict the generalizability of the results to other schools with similar inclusion and exclusion criteria, highlighting the need for larger sample sizes in future studies.

Among the strengths of this study is the fact that NAFLD diagnosis was performed via ultrasound by a qualified medical specialist. Additionally, validated and calibrated instruments were used, enhancing the accuracy of the results. Furthermore, the study adhered strictly to the procedures detailed in the approved research protocol, with no deviations during its implementation.

In this study, the estimated prevalence of NAFLD diagnosed by ultrasound among obese adolescents aged 12 to 14 years was 34.8%. Therefore, it is essential to implement educational strategies targeting caregivers and overweight adolescents to promote a balanced diet and physical activity, especially in those with an ultrasound diagnosis of NAFLD.

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