Received: 19 May 2023 | Accepted: 3 March 2024

DOI: 10.1002/jpr3.12072

ORIGINAL ARTICLE

Hepatology

Patient perspective on exercise practices, preferences, and barriers in pediatric nonalcoholic fatty liver disease: A multicenter survey

Elizabeth L. Yu[1,2] | Hyeri You[3] | Bryan Rudolph[4] | Jennifer A. Panganiban[5] | Taisa J. Kohut[6] | Henry C. Lin[7] | Amanda C. Fifi[6] | Rasmita Budhathoki[6] | Megan W. Butler[8] | Sabina R. Anderson[9] | Nidhi P. Goyal[1,2] | Kimberly P. Newton[1,2] | Jeffrey B. Schwimmer[1,2]

[1]Department of Pediatrics, Division of Gastroenterology, Hepatology and Nutrition, University of California San Diego School of Medicine, La Jolla, California, USA

[2]Department of Gastroenterology, Rady Children's Hospital San Diego, San Diego, California, USA

[3]Health Sciences Clinical and Translational Research Institute, University of California San Diego, La Jolla, California, USA

[4]Department of Pediatrics, Division of Gastroenterology, Hepatology and Nutrition, Children's Hospital at Montefiore, Albert Einstein College of Medicine, Bronx, New York, USA

[5]Department of Pediatrics, Perelman School of Medicine at the University of Pennsylvania, Division of Gastroenterology, Hepatology and Nutrition, Children's Hospital of Philadelphia, Philadelphia, Pennsylvania, USA

[6]Department of Pediatrics, Miller School of Medicine, Division of Pediatric Gastroenterology, Hepatology, and Nutrition, University of Miami, Miami, Florida, USA

[7]Department of Pediatrics, Division of Pediatric Gastroenterology, Hepatology and Nutrition, Doernbecher Children's Hospital, Oregon Health & Science University, Portland, Oregon, USA

[8]Department of Pediatrics, Division of Gastroenterology, Hepatology and Nutrition, Arkansas Children's Hospital, University of Arkansas for Medical Sciences, Little Rock, Arkans, USA

[9]Amherst College, Amherst, Massachusetts, USA

Correspondence

Jeffrey B. Schwimmer, Fatty Liver Clinic, Rady Children's Hospital San Diego and UC San Diego, 3020 Children's Way, MC 5030, San Diego, CA 92123, USA.
Email: jschwimmer@ucsd.edu

Funding information

National Institutes of Health, Grant/Award Number: UL1TR001442

Abstract

Background/Aims: Nonalcoholic fatty liver disease (NAFLD) is prevalent among children, and lifestyle modification is the primary treatment approach. However, the optimal exercise duration, frequency, and intensity for managing NAFLD remain undefined. This study aimed to gain insights from the patient perspective by examining exercise behaviors, preferences, and barriers in children with NAFLD.

Methods: A multicenter survey was conducted among children 8–18 years with NAFLD in pediatric gastroenterology clinics. Participants completed a questionnaire on exercise practices, preferences, and barriers, while parents completed a questionnaire on their willingness and ability to support their child's exercise. Data were analyzed using χ^2 test with Yates' correction and two-sample *t* test.

Results: The study included 408 children with NAFLD, with a mean age of 13.8 years. Approximately 52.5% of participants had physical education classes at school, while 59.5% engaged in extracurricular exercise, averaging 3.7 days per week. However, 11.5% reported no physical activity. A significant

majority (81.1%) expressed interest in increasing their exercise levels, primarily driven by health-related factors. Time-related constraints were the most cited barriers to exercise (53.7%). Approximately 80% of parents demonstrated willingness and ability to support their child's exercise regimen.

Conclusion: This study provides insights into exercise behaviors, preferences, and barriers among children with NAFLD. Half of the children lacked exercise opportunities at school but expressed interest in increasing their physical activity. Time limitation was the major obstacle cited. Parents are motivated to support increased physical activity. Exercise intervention programs for NAFLD should consider the perspective of the children and their families.

KEYWORDS

barriers to exercise, bicycling, motivation to exercise, physical activity, walking

1 | INTRODUCTION

Nonalcoholic fatty liver disease (NAFLD) is a growing concern among pediatric gastroenterologists in the United States.[1] The prevalence of NAFLD in children is estimated to be 5%–10% and is on the rise.[2–4] Children with NAFLD are at risk for serious non-hepatic comorbidities such as type 2 diabetes, dyslipidemia, hypertension, and depression, and may progress to advanced liver disease, including fibrosis, cirrhosis, and potentially requiring liver transplantation in early adulthood.[5,6] Consequently, there is an increasing awareness of the burden of disease in children with NAFLD and a need for finding optimal therapies.

Guidelines for treatment of NAFLD in children[7] recommend lifestyle modifications with improved diet and increased physical activity as first-line treatment. Although guidelines encourage moderate to high-intensity physical activity, they do not provide specific guidance on the target duration or frequency. According to a 2019 clinical practice survey of pediatric gastroenterologists across the United States, nearly all recommend physical activity for children with NAFLD, and approximately 70% make recommendations about duration and/or frequency.[1] However, data are limited regarding the current physical activity practices, preferences, motivations and barriers in children with NAFLD.

To better inform future exercise trials, it is crucial to understand the current exercise practices and preferences, as well as the barriers to exercise, experienced by children with NAFLD. This study aimed to contribute to the optimal design of future studies on exercise in children with NAFLD by assessing current exercise practices, evaluating exercise preferences, and identifying barriers to exercise in this population. A better understanding of the patient perspective will be necessary to develop effective interventions and improve outcomes for children with NAFLD.

What is Known

- Pediatric clinical guidelines advise increasing physical activity, especially moderate to vigorous exercise, for the treatment of non-alcoholic fatty liver disease (NAFLD).
- Pediatric gastroenterologists have widely varying exercise recommendations for children with NAFLD.

What is New

- Four out of five children with NAFLD want to exercise more than they currently do.
- For children interested in additional exercise, bicycling and walking were the most preferred activities.

2 | METHODS

2.1 | Study population

The study population comprised children between the ages of 8 and 18 years who were diagnosed with NAFLD and were recruited from tertiary care clinics at six different academic institutions across the United States. The diagnosis of NAFLD was established based on local standards using liver histology, imaging, and/or laboratory data. With a robust sample size of 400 survey participants, we can accurately estimate the frequency of a distribution within the 95% confidence interval with a precision of ±3%.

2.2 | Questionnaire design and process

The questionnaires, available in English and Spanish, were administered to participants by their treating

gastroenterologist. Data were collected from October 2019 through August 2021, with a temporary interruption from March 2020 to September 2020 due to the coronavirus disease (COVID-19) pandemic. During the clinic visit, participants completed a 12-item questionnaire regarding their current exercise practices, preferences, and perceived barriers to exercise. A separate three-item questionnaire was completed by parents of participants, addressing optimal time and monetary support for exercise.

To ensure comprehensive data collection, the questionnaire was designed using three separate validated instruments. The pediatric activity questionnaire-child/adolescent (PAQ-C/A)[8] was used to assess current exercise practices, the Stroke exercise preference inventory (SEPI)[9] for exercise to determine exercise preferences, and the Pediatric obesity exercise barriers identified by Zabinski et al.[10] to identify perceived barriers to exercise. The questionnaire captured information on sex, age, participation in physical education (PE) and recess at school, non-PE related exercise activity, physical activity of interest, access to exercise equipment, with whom participants would like to exercise, motivations, and perceived barriers to exercise, as well as parental exercise habits. Given the age range of 8–18 years within the study, we incorporated elements from both the elementary school/child and high school/adolescent versions of the Pediatric Activity Questionnaire. While a total of 19 questions are present in the combined elementary and high school questionnaires (10 for elementary and 9 for high school), the questions shared significant similarity across both levels. During the questionnaire creation, several questions were combined into multipart inquiries to streamline the process. The parent questionnaire encompassed three distinct questions designed to gather information regarding parental support for their child's exercise endeavors, as well as their perception of the optimal time for their child to engage in physical activities.[8] Participants provided verbal consent before completing the questionnaire, and no personal health information was collected. Patients with NAFLD were invited to complete the questionnaire at the onset of their clinic visit, with the completion rate not explicitly tracked. Children were given the autonomy to read the questions independently whenever they were capable. When necessary, parents assisted the children in understanding the questions. The study was approved by the Institutional Review Board at University of California San Diego and participating institutions and adhered to the Helsinki guidelines for medical research. For a detailed view of the questionnaire, please refer to Appendix 1.

2.3 | Data analysis

Statistical analysis was performed using R 4.0.2 software (R Foundation for Statistical Computing) The χ^2 test was used for categorical outcomes and the two-sample *t* test was used for continuous outcomes, to compare data across different groups. Categorical variables were expressed as count (percentage) and continuous variables as mean (standard deviation [SD]). A $p < 0.05$ was considered statistically significant.

3 | RESULTS

3.1 | Demographics

Study participants consisted of 408 children diagnosed with NAFLD, with a mean age of 13.8 years (SD 2.83). As is typical of children with NAFLD, the majority of patients were male ($n = 287$, 70.3%). Diagnosis of NAFLD was established through liver histology in 218 children (53.4%), liver imaging in 110 children (27.0%), and laboratory testing in 90 children (19.6%). Please refer to Table 1 for further details.

TABLE 1 Demographics and exercise characteristics of the study population.

	Overall (*n* = *408*)
Age	13.81 years (2.83)
Sex	
Female	121 (30%)
Male	287 (70%)
Have PE at school	*n* = *406*
Y	213 (53%)
N	193 (47%)
Want to exercise more	*n* = *403*
Y	335 (83%)
N	68 (17%)
Parents exercise regularly	*n* = *400*
Y	135 (34%)
N	265 (66%)
Participate in exercise in addition to PE	*N* = *408*
Y	294 (72%)
N	114 (28%)
Have access to exercise	*n* = *403*
Y	351 (87%)
N	52 (13%)
Have identified barriers to exercise	*n* = *400*
Y	219 (55%)
N	181 (45%)

Abbreviations: N, no; PE, physical education; Y, yes.

3.2 | Current exercise habits

Of the 408 children with NAFLD, 213 (52.5%) reported having PE in school. Among those with PE, the mean frequency of sessions per week was 3.3 (SD 1.6), with each session lasting for an average of 50 min. PE was more common among children aged 8–12 years than among those aged 13–18 years (68.4% vs. 45.5%, $p < 0.001$). Recess was available for 31.9% ($n = 130$) of participants, and of these, 32.5% ($n = 41$) reported sitting down, 32.5% ($n = 41$) reported standing/walking, and 34.9% ($n = 44$) reported running/playing during recess.

Outside of school, 239 children (59.5%, $n = 239$) engaged in physical activities, with a mean of 3.7 days per week. Among the children who exercised outside of school, 13.8% ($n = 33$) exercised for 1 additional day, 49.0% ($n = 117$) reported 2–3 additional days, 17.6% ($n = 42$) reported 4 additional days, and 19.7% ($n = 47$) reported 5 additional days. A total of 163 children (40.5%) reported no physical activity outside of school.

In terms of physical activity, various patterns were identified among the participants. Of the 408 children with NAFLD, 8.6% ($n = 35$) relied solely on PE for exercise while 2.5% ($n = 10$) reported that recess was their only form of physical activity. For 26.4% ($n = 108$) of children, exercise outside of school was their only means of physical activity. Twenty-one (5.1%) children engaged in both PE and recess while 6.1% ($n = 25$) participated in recess and extracurricular activity. In total, 19.8% ($n = 81$) of children reported engaging in both PE and additional physical activity outside of school. Furthermore, 18.1% ($n = 75$) of children engaged in all three routes of physical activity, including PE, recess, and additional physical activity outside of school. Meanwhile, 11.5% ($n = 47$) reported no physical activity of any kind. Of the 408 participants, six provided incomplete responses, leading to the discrepancy between the sum of reported activities (402) and the actual total number of participants (408). Please refer to Figure 1 for a visual representation of these patterns.

In terms of the most common types of exercise, walking ($n = 137$, 33.6%), running ($n = 112$, 27.5%), basketball ($n = 47$, 11.5%), and bike riding ($n = 47$, 11.5%) were the most frequently reported. The majority of participants ($n = 351$, 86.0%) reported access to physical activity, with neighborhood parks or playgrounds ($n = 146$, 35.8%), bikes ($n = 118$, 28.9%), and home gym equipment ($n = 109$, 26.7%) being the most commonly cited means of access. Please see Figure 2 for additional details.

3.3 | Exercise preferences

The majority of participants reported that they would like to exercise more than their current pattern ($n = 335$, 81.1%). Walking ($n = 204$, 50.0%), bicycling ($n = 148$, 36.2%), and running ($n = 117$, 28.7%) were the most preferred activities. Please see Figure 2. Males were more likely to express a desire to run than females (32.4% vs. 19.8%; $p = 0.015$), while females were more likely to express interest in walking with friends/family (28.3% vs. 16.4%; $p = 0.010$). Among those interested in participating in team or group exercises, basketball ($n = 89$/, 21.8%), walking with friends ($n = 81$, 19.9%), and soccer ($n = 74$, 18.1%) were the most popular choices. Most participants ($n = 163$, 40.0%) preferred to exercise alone, followed by in a group ($n = 83$, 20.3%), with a family member ($n = 76$, 18.6%), with a friend ($n = 53$, 13.0%), and with a coach/trainer ($n = 36$, 8.8%). Adolescents were more likely than school-age children (ages 8–12) to prefer exercising alone (40.2% vs. 31.7%; $p = 0.003$). Of the 194 children who preferred to exercise indoors, the majority preferred to exercise at home ($n = 100$, 51.5%), followed by local gyms ($n = 68$, 35.1%), the Young Men's Christian Association (YMCA) ($n = 20$, 10.3%), and community centers ($n = 6$, 3.1%). Optimal times for exercise were after school ($n = 238$, 58.3%), in the evening ($n = 194$, 47.5%), and on the weekend ($n = 187$, 45.8%). Before school was not a popular time to exercise, with only 9.3% ($n = 38$) of respondents choosing this time.

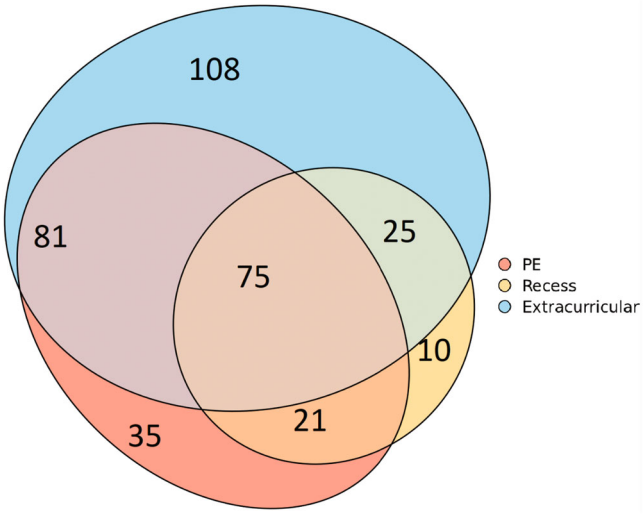

FIGURE 1 Euler diagram illustrating the patterns of physical activity reported by children with NAFLD, including the inter-relationships between PE, recess, and extracurricular physical activity. The figure above displays the various types of physical activity reported by study participants, including those who engaged in PE alone, recess alone, extracurricular physical activity alone, and various combinations such as PE/recess, PE/extracurricular physical activity, PE/recess/extracurricular physical activity, and recess/extracurricular physical activity. The diagram highlights the inter-relationships between these different forms of physical activity, providing a visual representation of the complex patterns of physical activity engagement among children with NAFLD. Four hundred and two participants are represented as six participants had incomplete activity data. NAFLD, nonalcoholic fatty liver disease; PE, physical education.

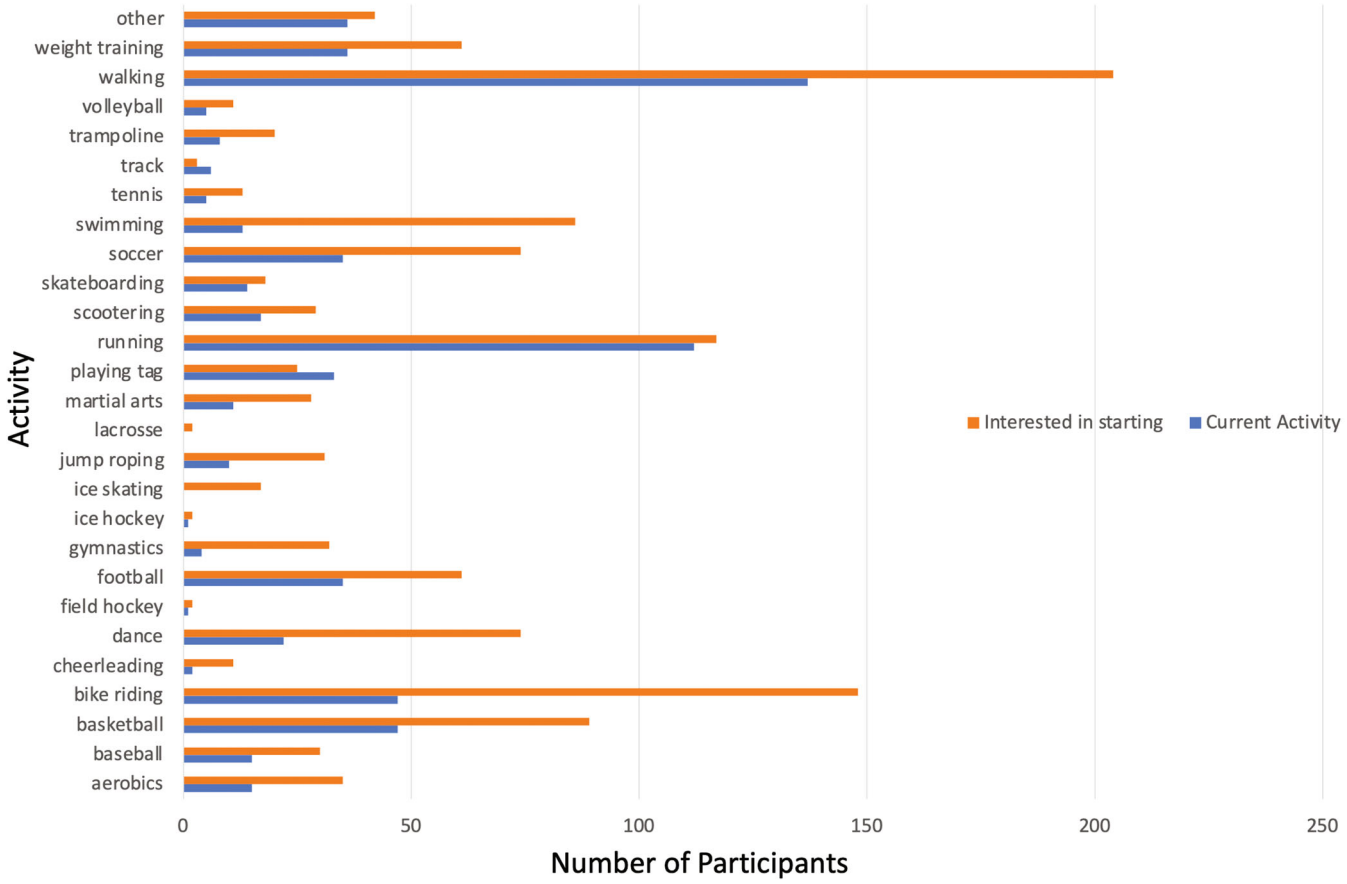

FIGURE 2 Current activities and stated interest in future activities. The figure above displays the various physical activity subtypes that participants currently participate in (blue) compared to physical activity subtypes that participants are interested in participating in (orange). Currently, walking, running, basketball, and bike riding are the most common activities. Participants would most like to engage in walking, bike riding, running, and basketball.

3.4 | Motivation

Among participants, the most reported motivating factors for exercise were to "be healthy" ($n = 228$, 55.9%), "weight loss" ($n = 194$, 47.5%), "doctor recommended" ($n = 156$, 38.2%), and "for my liver" ($n = 147$, 36.0%). Please refer to Table 2 for details. Adolescents were more likely than school-age children (ages 8–12) to cite weight loss as a motivating factor for exercise (52.0% vs. 36.8%; $p = 0.009$). Furthermore, children's desire to exercise more was related to their current exercise frequency. Those who exercised once a week or 2–3 times a week expressed greater interest in increasing exercise ($n = 29/33$ or 87.9% and $n = 106/117$ or 90.6%, respectively) compared to those who did not exercise at all ($n = 133/163$ or 81.6%) or those who exercised five times a week ($n = 34/47$ or 73.9%). Regardless of their current exercise level, most participants expressed a desire to exercise more. Of the 408 participants, 68 children (16.7%) expressed a lack of interest in participating in additional exercise. Among these children, the majority ($n = 49$, 72.1%) already exercised independently with an average frequency of 4.66 days per week.

3.5 | Barriers to exercise

In this study, more than half of the participants ($n = 219$, 53.7%) reported barriers to exercise. The most cited barriers were "too much homework" (18.1%), "not enough time" (16.4%), and "lack of interest" (15.7%). Males were more likely to cite "too much homework" (85.4% vs. 73.6%; $p = 0.007$) and "not enough time" (87.8% vs. 73.6%; $p < 0.001$) than females. Furthermore, 12.7% of the participants reported a lack of access to physical activity. Please refer to Table 2 for details.

3.6 | Parental factors

Of the children with NAFLD, approximately one-third reported having parents who exercised regularly ($n = 135$, 33.1%). Those with parents who exercised

TABLE 2 Motivating factors and barriers to exercise.

Motivating factor	Overall *N* (%)
To be healthy	228 (56%)
Weight loss	194 (48%)
Doctor recommended	156 (38%)
For my liver	147 (36%)
My family wants me to exercise	113 (28%)
To avoid getting a disease	76 (19%)
Enjoy exercise	74 (18%)
Exercising is fun/interesting	68 (17%)
To spend time with friends/family	55 (14%)
To be challenged	48 (12%)
People would be angry at me if I did not	25 (6%)
Other	12 (3%)
Barriers	
Too much homework	74 (18%)
Not enough time	67 (16%)
Lack of interest in exercise	64 (16%)
Lack of equipment	51 (13%)
Poor weather	49 (12%)
Don't want people to see my body	49 (12%)
Lack of convenient place to exercise	40 (10%)
Lack of skills/knowledge of how to exercise	38 (9%)
Do not have anyone to exercise with	34 (9%)
Cost	21 (5%)
Lack of parental supervision	15 (4%)
Distance	14 (3%)
Physical activity is too much work	14 (3%)
Too overweight to exercise	12 (3%)
Other	11 (3%)
Being active is physically uncomfortable	9 (2%)
Musculoskeletal injury	1 (0.2%)
Friends tease me	4 (1%)

regularly were more likely to participate in exercise outside of school ($n = 108/135$ or 80% vs. 179/265 or 67.5%; $p = 0.012$). Most parents ($n = 329$ or 80.6%) were willing and able to spend money to support their child's opportunity for exercise. The distribution of available funding was \$5–20/month ($n = 142$, 34.8%), \$20–\$40/month ($n = 124$, 30.4%), \$50–100/month ($n = 38$, 9.3%), and >\$100/month ($n = 23$, 5.6%). Parents of children with NAFLD diagnosed via liver histology were more likely to spend higher amounts monthly (\$50–100) to support their children's exercise compared to those diagnosed via imaging/laboratory data ($n = 29/178$, 16.3% vs. n = 9/187, 4.8%, $p = 0.003$). Most parents were willing and able to provide transportation ($n = 335$, 82.1%) to support their child's opportunity for exercise. The distribution of distance parents were willing to travel was >10 miles ($n = 120$, 29.4%), 5–10 miles ($n = 111$, 27.2%), and ≤5 miles ($n = 98$, 24.0%).

4 | DISCUSSION

In a multicenter study of 408 children with NAFLD, we examined exercise practices, preferences, and barriers. Almost 9 out of 10 children with NAFLD reported engaging in physical activity, with the majority expressing an interest in exercising more than they currently do. Notably, just over half participated in PE at school and for approximately 1 in 11 children with NAFLD, PE was their sole physical activity. Over half of the children cited barriers to physical activity, with self-reported time spent on homework and lack of interest in exercise being the most common. For children interested in additional exercise, bicycling and walking were the most preferred activities. The primary motivating factors for exercise were to improve health, weight, and liver status. We also found that children with NAFLD whose parents engaged in regular exercise were more likely to participate in exercise outside of school PE.

The American Academy of Pediatrics (AAP), World Health Organization (WHO) and the US Department of Health and Human Services have recommended at least 60 min of moderate to vigorous activity daily for children aged 6–17 years.[11–13] In children with NAFLD, NASPGHAN recommends increased moderate to high-intensity physical activity as first-line treatment[7] and nearly all US pediatric gastroenterologists counsel patients with NAFD on exercise.[1] While the specific duration, frequency and type of exercise recommended may vary, guidelines for exercise are in place to maintain or improve overall health and reduce the risk of chronic diseases.[14,15] However, these recommendations may not fully account for the nuances of chronic health conditions. Therefore, it is advisable to investigate the impact of exercise in subgroups of children with various chronic diseases, including NAFLD.

Previous research has suggested that exercise can improve NAFLD, independent of weight loss. Exercise has been shown to improve peripheral insulin resistance and increase fatty acid oxidation, which leads to a reduction in excess delivery of free fatty acids (FAAs) and glucose for hepatic FFA synthesis as well as the release of injury-associated molecular pathways.[16–18] Short term (i.e., 12 weeks) exercise interventions in children and adolescents with obesity have demonstrated potential for a mild to moderate benefit on

hepatic steatosis without showing a clear difference by exercise type or intensity. However, prior studies have evaluated the effects of exercise in children selected for obesity, rather than for having NAFLD. For instance, in a study by Van der Heijden and colleagues, 15 Hispanic adolescents with obesity participated in a 12-week moderately intense aerobic exercise program, resulting in a decrease in mean liver steatosis measured by magnetic resonance spectroscopy from 8.9% to 5.6%.[19] Lee and colleagues evaluated the effects of 12 weeks of aerobic versus resistance exercise programs in sedentary adolescents with obesity and found small decreases in intrahepatic lipid content (1%–2%).[20] Therefore, while exercise is associated with a reduction in hepatic steatosis, the specifics of which exercise, at what intensity and duration, is most helpful for NAFLD in children is unknown.

For patients with NAFLD, there are no specific recommendations for exercise duration or intensity beyond prevailing general population guidelines.[21–23] Previous studies have compared moderate and vigorous exercise in adult populations with NAFLD. Zhang and colleagues studied 220 patients over a 12-month period and compared moderate-vigorous exercise (jogging) to moderate exercise (brisk walking) and a control group. No significant difference in intrahepatic fat content, measured via MR spectroscopy, was found between moderate-vigorous and moderate exercise. Thus, it was concluded that vigorous and moderate exercise are equally effective in reducing intrahepatic triglyceride content.[24] Knowing individual patient preferences or ability becomes important since the type or intensity of exercise does not seem to affect the reduction of hepatic steatosis. Furthermore, exploring individual current exercise practices, preferences and barriers can lead to optimized, collaborative, individualized counseling. For patients motivated by liver health to increase physical activity, discussing transaminase levels could indeed be a valuable catalyst. Such discussions might enhance motivation and subsequently improve exercise levels. Please see Table 3 for a clinically actionable stepwise counseling approach.

In this study, the most desired additional exercise was walking. The recommended daily amount of moderate-vigorous physical activity for children is at least 60 min, which equates to 13,000–15,000 steps per day for boys and 11,000–12,000 steps per day for girls.[25] Prior studies have demonstrated significant reductions in obesity in school children aged 6–12 years by increasing weekend and holiday walking to more than 10,000 steps per day.[26] Similarly, studies have shown that increasing daily steps in children with overweight or obesity leads to a decrease in body mass index (BMI).[27] Whether increased steps have long-lasting effects on BMI and health is uncertain. Initiatives aimed at promoting walking through public health campaigns and increasing walkability may be helpful. Walking is an attractive form of exercise as it is affordable and widely accessible. School-based exercise is another population-level strategy that could aid in achieving recommended physical activity levels. In this study, over half of participants had PE classes, and for approximately 9%, PE was their only form of exercise. In the general population, about 30% of high school students have daily PE. If PE were mandatory, the recommended physical activity guidelines could be more readily met.

In this study, the most common types of physical activity currently engaged in were walking, running, basketball and bike riding. In a 2006 study by Grieser and colleagues, that utilized interviews of adolescent girls from different socioeconomic statuses and ethnicities across the United States, running was also the second most common type of exercise currently

TABLE 3 Holistic approach to counseling patients with NAFLD based on current exercise practices, preferences, and stated barriers.

Step 1	Data-driven conversation	Utilize the questionnaire findings as a starting point for open conversations with patients. Discuss their current exercise habits, preferences, and any perceived obstacles they face.
Step 2	Preference mapping	Map out the types of activities that resonate with each child. Tailor your recommendations by incorporating activities that align with their interests, ensuring a higher likelihood of adherence.
Step 3	Barrier resolution	Address identified barriers together with the patient and their family. Collaboratively find solutions to common obstacles such as time constraints, homework load, or resource availability.
Step 4	Goal setting	Collaboratively set achievable goals. These should be aligned with the child's preferences, considering their school schedule, extracurricular commitments, and family support.
Step 5	Gradual progression	Encourage gradual progression to prevent overwhelming changes. Start with manageable goals and incrementally increase physical activity levels over time.
Step 6	Parental involvement	Leverage parental engagement by sharing data on parent-child relationships in relation to exercise. Foster a supportive environment at home, where parents actively encourage and partake in physical activities.
Step 7	Ongoing evaluation	Regularly review progress together and adjust strategies as needed. This iterative process ensures the child's evolving needs are met effectively.

Abbreviation: NAFLD, nonalcoholic fatty liver disease.

engaged in.[28] In this 2006 study, indoor chores were the most common physical activity that adolescent girls engaged in while, in contrast, our study demonstrated that walking was the most common physical activity engaged in. Direct comparisons between exercise preferences in our study and those of children with similar demographics and clinical features are challenging due to limited available data. Notably, a general population study of adolescent girls identified basketball, dance, swimming, and running as the most preferred activities, demonstrating partial overlap with our patient cohort's preferences of walking, bicycling, and running.[28]

In a Polish sample of children and adolescents with overweight and obesity, the most frequently perceived barriers to exercise were lack of energy, time, and support. The largest motivating factor in this cohort was to improve health. Similarly, in our cohort of patients with NAFLD, too much homework and not enough time were the largest barriers and the most common motivator was "to be healthy."[29]

The present study has several strengths, including a large sample size and data collection from multiple pediatric gastroenterology centers across the United States. However, there were notable limitations. The reliance on self-reported exercise participation introduces potential bias, and questionnaire collection faced disruptions during the COVID-19 pandemic. Because the response rate was not tracked there may have been response bias. Additionally, BMI data were not available, and the absence of sociodemographic information may impact the assessment of patient-specific barriers to exercise. The study design did not incorporate longitudinal follow-up, highlighting areas for future research.

5 | CONCLUSION

This study surveyed children with NAFLD across multiple pediatric gastroenterology centers in the United States to assess their exercise behaviors and attitudes. The study revealed that only half of the children with NAFLD engaged in exercise through school, and the majority reported exercising on their own. Walking was the preferred physical activity for most participants. The primary motivating factor for children to exercise was to take an active role in their individual health. Time constraints were reported as the major barrier to exercise. Implementing physical activity during school hours would be an ideal solution to increase physical activity levels in children with NAFLD. Additionally, exercise intervention programs for NAFLD should consider patients' exercise behaviors and attitudes in their design. Based on Prochaska's stages of readiness,[30] most children in this study were in the preparation stage, contemplating possibilities and barriers. Future exercise studies should consider meeting children at their stage of readiness and assist in progressing to the action and maintenance stages for the highest success.

ACKNOWLEDGMENTS

The authors do not have any financial disclosures. The project described was partially supported by the National Institutes of Health, Grant UL1TR001442. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

REFERENCES

1. Shapiro WL, Yu EL, Arin JC, et al. Clinical practice approach to nonalcoholic fatty liver disease by pediatric gastroenterologists in the United States. *J Pediatr Gastroenterol Nutr*. 2019;68(2):182-189.
2. Schwimmer JB, Deutsch R, Kahen T, Lavine JE, Stanley C, Behling C. Prevalence of fatty liver in children and adolescents. *Pediatrics*. 2006;118(4):1388-1393.
3. Yu EL, Schwimmer JB. Epidemiology of pediatric nonalcoholic fatty liver disease. *Clin Liver Dis*. 2021;17(3):196-199.
4. Sahota AK, Shapiro WL, Newton KP, Kim ST, Chung J, Schwimmer JB. Incidence of nonalcoholic fatty liver disease in children: 2009-2018. *Pediatrics*. 2020;146(6):e20200771.
5. Pacifico L, Nobili V, Anania C, Verdecchia P, Chiesa C. Pediatric nonalcoholic fatty liver disease, metabolic syndrome and cardiovascular risk. *World J Gastroenterol*. 2011;17(26):3082-3091.
6. Zezos P. Liver transplantation and non-alcoholic fatty liver disease. *World J Gastroenterol*. 2014;20(42):15532-15538.
7. Vos MB, Abrams SH, Barlow SE, et al. NASPGHAN clinical practice guideline for the diagnosis and treatment of non-alcoholic fatty liver disease in children: recommendations from the Expert Committee on NAFLD (ECON) and the North American Society of Pediatric Gastroenterology, Hepatology and Nutrition (NASPGHAN). *J Pediatr Gastroenterol Nutr*. 2017;64(2):319-334.
8. Kowalski KC, Crocker RE, Donen RM. *The Physical Activity Questionnaire for Older Children (PAC-C) and Adolescents (PAQ-A) Manual*. University of Saskatchewan; 2004.
9. Bonner NS, O'Halloran PD, Bernhardt J, Cumming TB. Developing the stroke exercise preference inventory (SEPI). *PLoS One*. 2016;11(10):e0164120.
10. Zabinski MF, Saelens BE, Stein RI, Hayden-Wade HA, Wilfley DE. Overweight children's barriers to and support for physical activity. *Obes Res*. 2003;11(2):238-246.
11. Lobelo F, Muth ND, Hanson S, Nemeth BA, COUNCIL ON SPORTS MEDICINE AND FITNESS, SECTION ON OBESITY. Physical activity assessment and counseling in pediatric clinical settings. *Pediatrics*. 2020;145(3):e20193992.
12. World Health Organization. *Global Recommendations on Physical Activity for Health*. World Health Organization; 2010.
13. US Dept of Health and Human Services. *2008 Physical Activity Guidelines for Americans*. US Dept of Health and Human Services; 2008:15-21.
14. Friel CP, Duran AT, Shechter A, Diaz KM. U.S. children meeting physical activity, screen time and sleep guidelines. *Am J Prev Med*. 2020;59(4):513-521.

15. U.S. Department of Health and Human Services. *Physical Activity Guidelines for Americans*. 2nd ed. U.S. Department of Health and Human Services; 2018:46-54. https://health.gov/sites/default/files/2019-09/Physical_Activity_Guidelines_2nd_edition.pdf#page=46
16. Marchesini G, Petta S, Dalle Grave R. Diet, weight loss, and liver health in nonalcoholic fatty liver disease: pathophysiology, evidence, and practice. *Hepatology*. 2016;63:2032-2043.
17. Neuschwander-Tetri BA. Hepatic lipotoxicity and the pathogenesis of nonalcoholic steatohepatitis: the central role of nontriglyceride fatty acid metabolites. *Hepatology*. 2010;52(2):774-788.
18. van der Windt DJ, Sud V, Zhang H, Tsung A, Huang H. The effects of physical exercise on fatty liver disease. *Gene Expr*. 2018;18(2):89-101.
19. Van der Heijden GJ, Wang ZJ, Chu ZD, et al. A 12-week aerobic exercise program reduces hepatic fat accumulation and insulin resistance in obese, hispanic adolescents. *Obesity*. 2010;18(2):384-390.
20. Lee S, Bacha F, Hannon T, Kuk JL, Boesch C, Arslanian S. Effects of aerobic versus resistance exercise without caloric restriction on abdominal fat, intrahepatic lipid, and insulin sensitivity in obese adolescent boys. *Diabetes*. 2012;61(11):2787-2795.
21. Younossi ZM, Corey KE, Lim JK. AGA clinical practice update on lifestyle modification using diet and exercise to achieve weight loss in the management of nonalcoholic fatty liver disease: expert review. *Gastroenterology*. 2021;160(3):912-918.
22. Chalasani N, Younossi Z, Lavine JE, et al. The diagnosis and management of non-alcoholic fatty liver disease: practice guideline by the American Association for the Study of Liver Diseases, American College of Gastroenterology and the American Gastroenterological Association. *Hepatology*. 2012;55(6):2005-2023.
23. European Association for the Study of the Liver, European Association for the Study of Diabetes, European Association for the Study of Obesity. EASL-EASD-EASO Clinical Practice Guidelines for the management of non-alcoholic fatty liver disease. *J Hepatol*. 2016;64(4):1388-1402.
24. Zhang HJ, He J, Pan LL, et al. Effects of moderate and vigorous exercise on nonalcoholic fatty liver disease: a randomized clinical trial. *JAMA Intern Med*. 2016;176(8):1074-1082.
25. Tudor-Locke C, Craig CL, Beets MW, et al. How many steps/day are enough? For children and adolescents. *Int J Behav Nutr Phys Act*. 2011;8:78.
26. Yoshinaga M, Miyazaki A, Aoki M, et al. Promoting physical activity through walking to treat childhood obesity, mainly for mild to moderate obesity. *Pediatr Int*. 2020;62(8):976-984.
27. Staiano AE, Beyl RA, Hsia DS, et al. Step tracking with goals increases children's weight loss in behavioral intervention. *Child Obes*. 2017;13(4):283-290.
28. Grieser M, Vu MB, Bedimo-Rung AL, et al. Physical activity attitudes, preferences, and practices in African American, Hispanic, and Caucasian girls. *Health Educ Behav*. 2016;33(1):40-51.
29. Jodkowska M, Oblacińska A, Nałęcz H, Mazur J. Perceived barriers for physical activity in overweight and obese adolescents and their association with health motivation. *Dev Period Med*. 2017;21(3):248-258.
30. Norcross JC, Krebs PM, Prochaska JO. Stages of change. *J Clin Psychol*. 2011;67(2):143-154.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Yu EL, You H, Rudolph B, et al. Patient perspective on exercise practices, preferences, and barriers in pediatric nonalcoholic fatty liver disease: a multicenter survey. *JPGN Rep*. 2024;5:317-325. doi:10.1002/jpr3.12072