REFERENCES

1. Graziadei IW, Wiesner RH, Batts KP, et al. Recurrence of primary sclerosing cholangitis following liver transplantation. *Hepatology*. 1999;29:1050-1056.
2. Broomé U, Bergquist A. Primary sclerosing cholangitis, inflammatory bowel disease, and colon cancer. *Semin Liver Dis*. 2006;26:031-041.
3. Weismüller TJ, Trivedi PJ, Bergquist A, et al. Patient age, sex, and inflammatory bowel disease phenotype associate with course of primary sclerosing cholangitis. *Gastroenterology*. 2017;152:1975-1984.e8.
4. Pavlides M, Cleland J, Rahman M, et al. Outcomes after ileal pouch anal anastomosis in patients with primary sclerosing cholangitis. *J Crohns Colitis*. 2014;8:662-670.
5. Trivedi PJ, Reece J, Laing RW, et al. The impact of ileal-pouch-anal anastomosis on graft survival following liver transplantation for primary sclerosing cholangitis. *Aliment Pharmacol Ther*. 2018;48:322-332.

DOI: 10.1111/apt.14915

Editorial: being out of shape may impact more than your figure

Healthy eating and increased physical activity targeted towards weight loss remain first line therapy for nonalcoholic fatty liver disease (NAFLD) and nonalcoholic steatohepatitis (NASH).[1] Despite a strong body of evidence supporting these lifestyle behaviours, a significant knowledge gap persists regarding the highest yield approach for dietary changes and physical activity regimens and predictors of likelihood to achieve improvements in steatosis and histologic components of NASH. Specifically, the pathophysiologic mechanism driving these histologic improvements and the role cardiorespiratory fitness plays in mediating or moderating this relationship requires further characterisation.

In a recent issue, Argo et al investigated the association between aerobic fitness, anthropometrics, fat distribution on imaging, self-reported physical activity and histologic components of NASH.[2] In this cross-sectional analysis, 36 overweight or obese patients with biopsy-proven NASH [NAFLD activity score (NAS) $\geq$4, mean fibrosis score 1.7) completed exercise testing (V02 analysis) and were compared to 148 sedentary control subjects without known metabolic disease as well as age and gender-matched controls. Interestingly, among NASH patients, fitness was similar in obese and overweight individuals and was not correlated with visceral adiposity or histologic components of NASH. Notably, NASH patients were significantly more deconditioned than sedentary controls and the general population.

This study has several strengths including a detailed assessment of fitness using standardised measures and adjunctive MRI-based assessments of distribution of fat in a well characterised population of patients with biopsy-proven NASH. Several limitations worth highlighting include the small sample size, concerns regarding generalisability of both the case and control populations, the cross-sectional nature of the study and lack of nutritional assessment. Patients who had previously been selected to undergo liver biopsy as part of their general care probably represent a different cohort than the broader population of patients with underlying NASH. Also, subjects in this study had relatively minimal fibrosis (mean 1.7). It is also unclear if the control group, which consisted of individuals in the study lab, is representative of the general population.

Overall, this study adds to the existing body of literature on the role of physical fitness in NASH and outlines areas of interest to explore in future studies. Additional investigation into the relationship between fat distribution, histologic components of NASH, and other potential correlates between physical fitness and NASH is warranted given the paucity of data on this topic and conflicting results to date.[3-6] In particular, further delineation about how visceral adiposity and stage and grade of NASH mediates or moderates cardiorespiratory fitness and the propensity to respond to lifestyle interventions is needed. It would also be relevant to focus specifically on characterisation of sedentary behaviour such as total sitting time as this is a separate but related behaviour that probably impacts overall physical fitness and was not specifically evaluated in this study.[7] Most importantly, as highlighted by the authors, it would be of value to continue to evaluate the impact of change in physical fitness on liver disease burden, as lifestyle interventions remain first line therapy for this burgeoning disease.[8,9]

ACKNOWLEDGEMENTS

Declaration of personal interests: None.

FUNDING INFORMATION

None.

ORCID

M. A. Konerman http://orcid.org/0000-0002-8381-6149

LINKED CONTENT

This article is linked to Argo et al paper. To view this article visit https://doi.org/10.1111/apt.14803.

M. A. Konerman
Division of Gastroenterology and Hepatology, Department of Medicine, University of Michigan, Ann Arbor, MI, USA
Email: konerman@med.umich.edu

REFERENCES

1. Chalasani N, Younossi Z, Lavine JE, et al. The diagnosis and management of nonalcoholic fatty liver disease: practice guidance from the American Association for the Study of Liver Diseases. *Hepatology (Baltimore, MD)*. 2018;67:328-357.
2. Argo CK, Stine JG, Henry ZH, et al. Physical deconditioning is the common denominator in both obese and overweight nonalcoholic steatohepatitis (NASH). *Aliment Pharmacol Ther*. 2018;48:290-299.
3. Krasnoff JB, Painter PL, Wallace JP, Bass NM, Merriman RB. Health-related fitness and physical activity in patients with nonalcoholic fatty liver disease. *Hepatology (Baltimore, MD)*. 2008;47:1158-1166.
4. Church TS, Kuk JL, Ross R, Priest EL, Biltoft E, Blair SN. Association of cardiorespiratory fitness, body mass index, and waist circumference to nonalcoholic fatty liver disease. *Gastroenterology*. 2006;130:2023-2030.
5. Kantartzis K, Thamer C, Peter A, et al. High cardiorespiratory fitness is an independent predictor of the reduction in liver fat during a lifestyle intervention in non-alcoholic fatty liver disease. *Gut*. 2009;58:1281-1288.
6. Nguyen-Duy TB, Nichaman MZ, Church TS, Blair SN, Ross R. Visceral fat and liver fat are independent predictors of metabolic risk factors in men. *Am J Physiol Endocrinol Metab*. 2003;284:E1065-E1071.
7. Trenell MI. Sedentary behaviour, physical activity, and NAFLD: curse of the chair. *J Hepatol*. 2015;63:1064-1065.
8. Oh S, So R, Shida T, et al. High-intensity aerobic exercise improves both hepatic fat content and stiffness in sedentary obese men with nonalcoholic fatty liver disease. *Sci Rep*. 2017;7:43029.
9. Johnson NA, George J. Fitness versus fatness: moving beyond weight loss in nonalcoholic fatty liver disease. *Hepatology (Baltimore, MD)*. 2010;52:370-381.