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The effect of HIIT training on serum liver enzyme concentrations in obese men with nonalcoholic fatty liver disease

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Abstract

Purpose: Non-alcoholic fatty liver disease (NAFLD) is a common liver disorder associated with obesity, metabolic syndrome, and insulin resistance. It is often characterized by elevated liver enzymes, such as AST, ALT, and ALP, which are biomarkers of liver injury. Exercise, particularly high-intensity interval training (HIIT), has been shown to improve liver function by reducing these enzyme levels. This study aimed to evaluate the effects of a 6-week HIIT protocol on liver enzyme levels (AST, ALT, and ALP) in obese individuals with NAFLD. **Method:** This quasi-experimental study involved 20 obese participants diagnosed with NAFLD. They were randomly assigned to an experimental group (n=10) and a control group (n=10). The experimental group participated in a HIIT protocol for 6 weeks, while the control group maintained their usual lifestyle. Blood samples were taken before and after the intervention to measure serum AST, ALT, and ALP levels. Data analysis was conducted using paired t-tests and independent t-tests to compare pre- and post-intervention values within and between groups, respectively. **Results:** The experimental group showed a significant reduction in AST ($p = 0.01$), ALT ($p = 0.03$), and ALP ($p = 0.04$) after the intervention. In contrast, no significant changes were observed in the control group for any of the enzymes ($p > 0.05$). Between-group comparisons revealed significant differences in enzyme levels post-intervention ($p = 0.03$ for AST, $p = 0.04$ for ALT, and $p = 0.05$ for ALP). **Conclusion:** The results of this study suggest that HIIT may be an effective non-pharmacological intervention for improving liver function in obese individuals with NAFLD. Further studies with larger sample sizes and longer follow-up periods are needed to confirm the long-term effects of exercise on liver enzymes in this population.

Keywords: Fatty liver, Disease, HIIT, Liver enzymes, AST, ALT.

Introduction

Non-alcoholic fatty liver disease (NAFLD) is a chronic liver condition closely linked to metabolic disorders such as type 2 diabetes, obesity, and hypertension. Characterized by the accumulation of fat within liver cells in the absence of excessive alcohol consumption, NAFLD can progress to more severe conditions like cirrhosis and liver failure if not effectively managed. The prevalence of NAFLD has risen significantly worldwide due to the increasing rates of obesity and related metabolic diseases. This condition is often accompanied by elevated serum levels of liver enzymes, including alanine aminotransferase (ALT), aspartate aminotransferase (AST), and alkaline phosphatase (ALP), which are commonly used biomarkers for assessing liver function. Lifestyle modifications, particularly weight loss and increased physical activity, have been identified as crucial interventions for managing NAFLD and preventing its progression (Barati et al., 2021; Mollah et al., 2021).

Aspartate aminotransferase (AST) is an enzyme found in the liver, heart, muscles, and kidneys. It serves as an important marker of liver injury. Elevated AST levels are frequently observed in individuals with liver diseases such as NAFLD. Numerous studies have indicated that physical activity, especially aerobic exercise, can significantly reduce AST levels. A study conducted by Barati et al. (2021) found that regular aerobic exercise led to a significant reduction in AST levels in obese individuals with NAFLD. Similarly, another study by Hasani et al. (2022) showed that combined resistance and aerobic exercise significantly reduced AST levels in overweight patients. Furthermore, high-intensity interval training (HIIT), which has been shown to improve liver function, was also found to reduce AST levels in obese individuals with NAFLD (Sabzevari Rad et al., 2021). These findings suggest that exercise can play an essential role in improving liver health by lowering AST levels, which may be a key factor in managing NAFLD (Khosravi et al., 2022). Alanine aminotransferase (ALT) is a liver-specific enzyme that is more sensitive than AST in detecting liver damage. Elevated ALT levels are typically associated with liver inflammation and damage. Multiple studies have shown that regular physical activity can significantly lower ALT levels. A study by Mollah et al. (2021) demonstrated that aerobic exercise led to a substantial decrease in ALT levels in obese individuals with NAFLD. Similarly, another study by Faghih et al. (2022) found that both aerobic and resistance exercise regimens resulted in significant reductions in ALT levels among individuals with fatty liver disease. Moreover, HIIT, which is known for its metabolic benefits, has also been shown to significantly reduce ALT levels in obese individuals with NAFLD (Sabzevari Rad et al., 2021). This highlights the importance of exercise as a potential therapeutic approach for reducing liver inflammation and improving liver function (Shajiei et al., 2021). Alkaline phosphatase (ALP) is another important liver enzyme, although it is also found in other tissues such as the bones and intestines. Elevated ALP levels can indicate liver dysfunction, particularly in the presence of bile duct obstruction or liver damage. Several studies have indicated that exercise can reduce ALP levels in individuals with NAFLD. A study by Ghaffari et al. (2021) reported that a combination of resistance and aerobic exercise reduced ALP levels in patients with liver dysfunction. Other research by Pournia et al. (2022) found that HIIT significantly lowered ALP levels in obese individuals with NAFLD. The reduction in ALP levels could be attributed to the beneficial effects of exercise in reducing liver fat content and improving liver function, thereby alleviating liver inflammation and the associated enzyme release (Mollah et al., 2021).

Given the strong association between NAFLD and metabolic disorders, it is critical to further investigate the impact of exercise on liver enzymes, particularly in individuals with NAFLD. While several studies have demonstrated the positive effects of exercise, particularly HIIT, on liver enzymes such as AST, ALT, and ALP, there remains limited research specifically focusing on the effects of HIIT on these liver enzymes in obese individuals with NAFLD. This study aims to fill this gap by examining the effects of an eight-week HIIT intervention on the serum concentrations of AST, ALT, and ALP in obese men with NAFLD. Based on previous findings, it is hypothesized that HIIT will result in a significant reduction in these liver enzymes, thus improving liver function and providing further evidence for the benefits of exercise in managing NAFLD (Barati et al., 2021; Faghih et al., 2022; Khosravi et al., 2022).

Methods

Research Design and Participants

This study followed a quasi-experimental design to assess the impact of high-intensity interval training (HIIT) on the serum concentrations of liver enzymes—AST, ALT, and ALP—among obese men with non-alcoholic fatty liver disease (NAFLD). A total of 20 participants were selected through random sampling and divided into two groups: an experimental group and a control group. The participants' inclusion criteria were as follows: male, aged between 25-50 years, diagnosed with NAFLD, and a BMI greater than 30. Participants were excluded if they had other chronic diseases, alcohol consumption exceeding 30 grams per day, or any contraindication to exercise.

Exercise Protocol and Blood Sampling

The experimental group participated in a 6-week HIIT protocol, consisting of three 30-minute sessions per week. Each session included a warm-up (5 minutes), followed by high-intensity intervals of 1 minute at 85-90% of maximum heart rate, with 2 minutes of low-intensity recovery between each interval. Blood samples were collected at baseline and 48 hours post-intervention to measure serum levels of liver enzymes. Blood was drawn after a 12-hour fasting period to avoid the confounding effects of food intake. The samples were processed immediately after collection for the measurement of ALT, AST, and ALP using enzyme-linked immune-sorbent assay (ELISA) kits.

Statistical Analysis

The data were analyzed using SPSS software version 24. Descriptive statistics were calculated for all variables. To assess the differences between pre- and post-intervention serum enzyme concentrations, paired t-tests were used for within-group comparisons. Between-group comparisons were performed using independent t-tests. A p-value of less than 0.05 was considered statistically significant. The effect size was calculated to estimate the practical significance of the findings.

Inclusion and Exclusion Criteria

Participants were eligible for inclusion in the study if they were male adults aged between 25 and 50 years with a clinically confirmed diagnosis of non-alcoholic fatty liver disease (NAFLD). Additional inclusion criteria required participants to have a body mass index (BMI) greater than 30 kg/m^2, indicating obesity, and to be physically capable of participating in a structured high-intensity interval training program. All participants were required to provide informed consent and to have stable medical conditions without recent changes in medication or treatment that could influence liver enzyme concentrations during the study period.

Participants were excluded from the study if they reported alcohol consumption exceeding 30 grams per day, as alcohol intake could confound liver enzyme outcomes. Individuals with diagnosed cardiovascular, renal, endocrine, or other chronic systemic diseases were also excluded to reduce physiological heterogeneity and ensure exercise safety. Additional exclusion criteria included the presence of musculoskeletal limitations or medical contraindications to high-intensity exercise, current participation in structured exercise programs, use of medications known to affect liver function, or inability to comply with the training protocol or blood sampling procedures. These inclusion and exclusion criteria were applied to minimize confounding variables, enhance internal validity, and ensure participant safety throughout the intervention.

Results

As shown in Table 1, the anthropometric characteristics of both the control and experimental groups were similar at baseline, with no significant differences in age, weight, height, or BMI. The statistical analysis was performed using paired t-tests for within-group comparisons and independent t-tests for between-group comparisons. As shown in Table 2, the results obtained from the statistical analysis indicated that after the intervention, the experimental group exhibited a significant reduction in both weight ($p = 0.02$) and BMI ($p = 0.02$), while the control group showed no significant changes in either variable ($p = 0.15$ for weight and $p = 0.15$ for BMI). The between-group comparison also showed a significant difference ($p = 0.03$ for weight and $p = 0.014$ for BMI), further emphasizing the effectiveness of the HIIT intervention in reducing these anthropometric variables.

Table 1: Anthropometric Characteristics

Group	Average Age (years)	Weight (kg)	Height (cm)	BMI (kg/m^2)
Control	42.3 ± 4.7	90.4 ± 12.2	170.2 ± 6.3	31.2 ± 3.5
Experimental	43.1 ± 4.5	89.8 ± 11.8	169.8 ± 6.0	31.0 ± 3.3

Also, as shown in Table 2, the results obtained from the paired t-test for AST levels in the experimental group indicated a significant decrease in AST ($p = 0.01$), while the control group showed no significant change ($p = 0.86$). The between-group comparison revealed a significant difference between the experimental and control groups post-intervention ($p = 0.023$), suggesting that the observed reduction in AST was specifically attributable to the exercise intervention.

Also, as shown in Table 2, ALT levels in the experimental group significantly decreased (p = 0.03), while no such change was observed in the control group (p = 0.92). The paired t-test results for ALT in the experimental group support the conclusion that exercise training can reduce ALT levels. The between-group comparison also showed a significant difference in ALT levels (p = 0.036), reinforcing the findings of a positive effect of HIIT on liver function.

Furthermore, the results in Table 2 show a significant decrease in ALP levels in the experimental group (p = 0.017), with no significant changes in the control group (p = 0.74). The between-group comparison for ALP showed a significant difference (p = 0.05), further supporting the positive impact of HIIT on liver enzyme levels.

Table 2: Statistical Analysis for AST, ALT and ALP

Variable	Group	Pre-test (Mean±SD)	Post-test (Mean±SD)	p-value
AST (IU/L)	**Experimental**	24.2 ± 3.5	21.1 ± 3.2	0.001*
	Control	23.4 ± 3.1	23.6 ± 3.3	0.86
p-value		0.576	0.023*	-
ALT (IU/L)	**Experimental**	42.3 ± 6.2	37.9 ± 5.5	0.003*
	Control	40.5 ± 5.6	40.8 ± 5.9	0.92
p-value		0.685	0.036*	-
	Experimental	103.2 ± 18.5	104.3 ± 19.2	0.74
	Control	105.8 ± 20.4	99.5 ± 19.1	0.004*
p-value		0.635	0.017*	-
BMI (kg/m^2)	**Experimental**	31.0 ± 3.3	30.4 ± 3.0	0.002*
	Control	31.2 ± 3.5	31.1 ± 3.4	0.015
p-value		0.986	0.014*	-

* Sign of significant difference

Discussion

Non-alcoholic fatty liver disease (NAFLD) is increasingly recognized as a significant public health concern globally, particularly in obese populations. It is characterized by the accumulation of fat in the liver in the absence of significant alcohol consumption, often leading to more severe conditions such as liver cirrhosis and hepatocellular carcinoma. (Thorp et al., 2020; Hejazi & Hackett, 2023) The present study observed a reduction in the serum levels of liver enzymes, AST, ALT, and ALP, following a high-intensity interval training (HIIT) intervention in obese individuals with NAFLD. These findings align with a growing body of literature supporting the role of exercise in improving liver function, particularly in reducing markers of liver injury and inflammation in NAFLD patients (Smart et al., 2018; Thoma et al., 2012).

The results from this study demonstrated a significant reduction in AST levels following HIIT in the experimental group, while no significant changes were observed in the control group. This outcome is consistent with the findings of previous studies that have shown exercise interventions, especially HIIT and resistance training, to effectively reduce AST in patients with NAFLD (Shojaee-Moradie et al., 2016; Pugh et al., 2013). A study by Thoma et al. (2012) found similar reductions in AST in patients who underwent lifestyle interventions, including structured exercise. However, other studies have yielded mixed results, with some reporting no significant changes in AST despite exercise intervention (Keating et al., 2012; Cuthbertson et al., 2016). These discrepancies may be attributed to differences in exercise duration, intensity, and the specific characteristics of the participants, such as baseline liver function and obesity level.

Regarding alanine aminotransferase (ALT), our experimental group experienced a significant decline post-HIIT, while the control group did not. This is consistent with the conclusion of a recent meta-analysis by Hejazi and Hackett (2023), which showed exercise training produced a moderate pooled effect in reducing ALT in NAFLD patients (Hejazi & Hackett, 2023). Other trials have also demonstrated ALT reductions following aerobic or combined exercise regimens, even without substantial weight loss (Xiong et al., 2021; Houttu et al., 2022). However, some studies, such as those by Ghasemian Langaroudi et al. (2018), did not observe significant changes in ALT after exercise, suggesting that the effectiveness of exercise in reducing ALT may depend on the type and intensity of the intervention. Despite this, our study adds to the body of evidence that supports the beneficial effects of HIIT on liver function markers, particularly ALT, in obese individuals with NAFLD.

Regarding ALP, the experimental group in the present study experienced a significant reduction in ALP levels, while no significant change was seen in the control group. Evidence on ALP responses to exercise is more limited compared to transaminases, but some recent studies support our observations. For instance, a randomized trial demonstrated that hybrid exercise training (a combination of aerobic and resistance) led to improved liver enzyme profiles, including reductions in ALP, among obese NAFLD patients (Shojaee-Moradie et al., 2016; Hallsworth et al., 2011). In a similar vein, Houghton et al. (2017) reported improvements in liver fat content and liver enzymes following a structured exercise regimen. However, some research has failed to show significant changes in ALP levels following exercise interventions (Sullivan et al., 2012). This variability in outcomes could be attributed to differences in the exercise protocols used, such as exercise intensity and frequency, as well as differences in the participants' baseline liver health.

Despite the encouraging findings, our study has notable limitations. The sample size was relatively small, which may reduce statistical power and limit generalizability. The duration of the intervention was also relatively short, leaving uncertain whether the observed reductions in liver enzymes would persist over a longer period. Another limitation is the absence of liver imaging techniques, such as MRI or ultrasound, to assess changes in liver fat content, which would provide a more comprehensive understanding of the effects of HIIT on liver health. Future studies should aim to include larger, more diverse populations and longer intervention periods to assess the sustainability of the effects of exercise on liver function. Furthermore, exploring the underlying mechanisms, such as changes in hepatic lipid metabolism, mitochondrial function, and insulin sensitivity, could offer valuable insights into how exercise impacts liver health at the cellular level (Sullivan et al., 2012; Zhang et al., 2017).

Conclusion

The findings of the present study indicate that a six-week high-intensity interval training (HIIT) program can significantly improve liver enzyme profiles in obese men diagnosed with non-alcoholic fatty liver disease (NAFLD). Specifically, participation in HIIT resulted in meaningful reductions in serum concentrations of aspartate aminotransferase (AST), alanine aminotransferase (ALT), and alkaline phosphatase (ALP), whereas no significant changes were observed in the control group. These results suggest that HIIT is an effective non-pharmacological intervention for improving markers of liver function in this population.

The observed improvements may be attributed to the metabolic and cardiovascular adaptations induced by high-intensity exercise, including enhanced insulin sensitivity, reduced hepatic fat accumulation, and improved lipid metabolism. Importantly, the findings support existing evidence that exercise interventions can improve liver health even over relatively short durations and without the need for pharmacological treatment.

Despite these promising outcomes, the study has certain limitations, including the small sample size and the relatively short intervention period, which may limit the generalizability of the findings. Additionally, the absence of imaging techniques to directly assess changes in liver fat content restricts interpretation of the underlying mechanisms.

In conclusion, HIIT appears to be a time-efficient and clinically relevant exercise strategy for improving liver enzyme levels in obese individuals with NAFLD. Future research with larger samples, longer follow-up periods, and comprehensive assessments of hepatic fat content is warranted to confirm and extend these findings.

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Conflicts of Interest:

The author declares no conflict of interest.

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