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Impact Of Weight Training With Vitamin Supplementation On Liver Enzymes And Uric Acid Among Females With Non-Alcoholic Fatty Liver Disease

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Abstract

Non-alcoholic fatty liver disease (NAFLD) is an increasingly prevalent metabolic disorder strongly associated with hyperuricemia, obesity, and insulin resistance, particularly among adult females. Elevated serum uric acid (SUA) contributes to oxidative stress and hepatic inflammation, accelerating NAFLD progression. Lifestyle-based interventions such as resistance exercise and micronutrient supplementation are emerging as effective non-pharmacological strategies. This study aimed to examine the combined effects of structured weight training and vitamin supplementation on SUA levels and liver function markers in females diagnosed with NAFLD.A randomized controlled experimental design was employed involving adult females (n = 20; 20–50 years) with ultrasound-confirmed NAFLD. Participants were randomly allocated into an experimental group (EG; weight training plus vitamin supplementation) or a control group (CG; routine physical activity). The intervention lasted eight weeks. Pre- and post-intervention assessments included body mass index (BMI), serum uric acid,

alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), and total bilirubin. Data were analyzed using paired and independent samples t-tests. The experimental group demonstrated statistically significant reductions in serum uric acid (Δ −1.21 mg/dL, $p < .01$), ALT (Δ −14.3 U/L, $p < .01$), AST (Δ −11.6 U/L, $p < .05$), ALP (Δ −18.4 U/L, $p < .01$), and BMI (Δ −1.9 kg/m², $p < .05$) compared to the control group. No adverse events were reported. Eight weeks weight training and vitamin supplementation significantly improved uric acid regulation and hepatic enzyme profiles in females with NAFLD. These findings support the use of integrated lifestyle-based interventions as effective therapeutic strategies for NAFLD management.

Introduction

Non-alcoholic fatty liver disease (NAFLD) has become the largest chronic liver disease worldwide, impacting about 30-38 percent of adults, and its level of incidence is rising more and more in females because of metabolic and hormonal factors (Riazi et al., 2022; Le et al., 2022). NAFLD is a hepatic expression of metabolic syndrome that is closely associated with obesity, insulin resistance, dyslipidemia, and general inflammation processes (Younossi et al., 2019). Hyperuricemia has been acknowledged as a metabolic risk factor by itself of NAFLD. High serum uric acid (SUA) causes mitochondrial oxidative stress, endothelium dysfunction, and hepatic lipogenesis, thus worsening steatosis and liver damage (Jensen et al., 2018; Heyens et al., 2021). The epidemiological data indicates that the relationship between SUA and NAFLD is more robust in women, especially post-menopausal women regardless of whether they are obese or not (Kosmalski, 2023). The management of NAFLD continues to be based on lifestyle interventions. Resistance exercises have proved to be effective in decreasing fat content in the liver, enhancing insulin sensitivity, and change of inflammatory processes without the requirement of weight reduction (Xu et al., 2019). At the same time, vitamin regulators, especially vitamins D, E, C, and zinc have been reported to have hepatoprotective and uricosuric effects by antioxidant and anti-inflammatory actions (Godoy-Matos et al., 2020; Abe et al., 2021). Although there is an increasing amount of evidence, few experimental studies have been conducted to demonstrate the combination of structured resistance training and vitamin supplementation in females with NAFLD. Additionally, not many studies have been conducted on the simultaneous analysis of uric acid and a complex of liver enzymes responses, which provides a great research gap filled by the current research.

METHODS AND MATERIALS

The current study was designed to examine the Impact of Weight Training with Vitamin Supplementation on Liver Enzymes and Uric Acid among Females with Non-Alcoholic Fatty Liver Disease; therefore, the researcher applied an experimental research design. Twenty (20) females (20–50 years) diagnosed with NAFLD were recruited from the University of the Punjab Fitness Centre. Participants were randomly allocated into an experimental group (EG; weight training plus vitamin supplementation) or a control group (CG; routine physical activity). Each group comprised ten (10) subjects. Inclusion criteria included ultrasound-confirmed fatty liver and absence of alcohol consumption or hepatic Comorbidities. A self-made exercise protocol was applied to EG. The intervention lasted eight weeks. The details of intervention with vitamins supplementation are (Weight Training: 3 sessions/week, moderate intensity (60–70% 1RM), whole-body protocol and Vitamin Supplementation: Vitamin D (2000 IU/day), Vitamin E (400 IU/day), Vitamin C (500 mg/day), Zinc (15 mg/day). Blood sample was collected from all the respondents and immediately transferred to the lab for biochemical analysis. Pre- and post-intervention

assessments included body mass index (BMI), serum uric acid, alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), and total bilirubin. Approval was obtained from the institutional ethics committee. Written informed consent was secured. The pre and post-test analyses were performed by using statistical package for the Social Sciences (SPSS, version 26) and thus, suitable statistical tools were applied.

PRESENTATION OF DATA

Table no.1 shows the Baseline the Anthropometric Characteristics of Participants

Variable	Control Group (n = 10) Mean ± SD	Experimental Group (n = 10) Mean ± SD	p-value
Age (years)	34.8 ± 7.2	35.1 ± 6.9	.912
Height (cm)	160.4 ± 5.6	161.1 ± 6.1	.781
Weight (kg)	75.2 ± 6.8	76.1 ± 7.3	.703
BMI (kg/m^2)	29.4 ± 2.3	29.6 ± 2.1	.861

At baseline, no statistically significant differences were observed between the control and experimental groups for age, height, weight, or BMI ($p > .05$), indicating successful randomization and baseline equivalence.

Table no.1 shows Within-Group Pre- and Post-Intervention Changes in BMI

Group	Pre-Test Mean ± SD	Post-Test Mean ± SD	Mean Difference	t-value	p-value
Control Group	29.4 ± 2.3	28.9 ± 2.2	−0.5	1.92	.087
Experimental Group	29.6 ± 2.1	27.7 ± 1.9	−1.9	4.63	.001

The experimental group demonstrated a statistically significant reduction in BMI following the 8-week intervention ($p = .001$), whereas the control group showed a non-significant decrease. This suggests that weight training combined with vitamin supplementation had a superior effect on body composition.

Table no.3 shows Within-Group Changes in Serum Uric Acid Levels (mg/dL)

Group	Pre-Test Mean ± SD	Post-Test Mean ± SD	Mean Difference	t-value	p-value
Control Group	6.6 ± 0.8	6.3 ± 0.7	−0.3	1.48	.172
Experimental Group	6.8 ± 0.9	5.6 ± 0.7	−1.21	5.12	.000

A marked and statistically significant reduction in serum uric acid was observed in the experimental group ($p < .001$). The control group exhibited only marginal, non-significant changes, highlighting the efficacy of the combined intervention in modulating hyperuricemia.

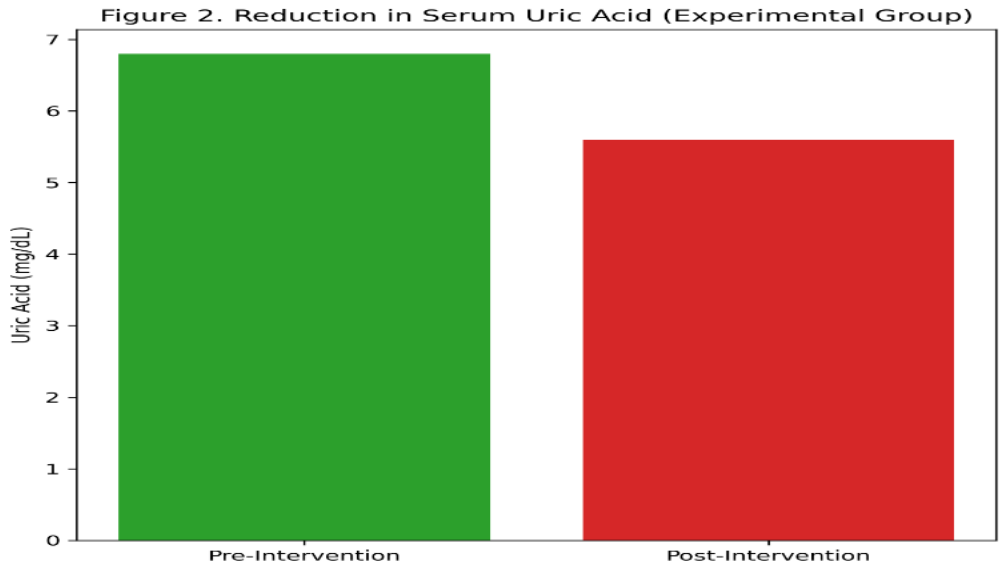

Fig 2 depicts the magnitude of uric acid reduction observed in the experimental group
Table no.4 shows tha Changes in Liver Enzymes: Alanine Aminotransferase (ALT, U/L)

Group	Pre-Test Mean ± SD	Post-Test Mean ± SD	Mean Difference	t-value	p-value
Control Group	46.9 ± 8.7	44.2 ± 8.3	−2.7	1.31	.221
Experimental Group	48.2 ± 9.4	33.9 ± 7.1	−14.3	4.87	.001

ALT levels decreased significantly in the experimental group (p = .001), indicating improved hepatocellular integrity. No meaningful change was detected in the control group, reinforcing the intervention's liver-protective effect.

Table no.5 shows Changes in Liver Enzymes: Aspartate Aminotransferase (AST, U/L)

Group	Pre-Test Mean ± SD	Post-Test Mean ± SD	Mean Difference	t-value	p-value
Control Group	41.5 ± 7.9	39.8 ± 7.6	−1.7	1.08	.306
Experimental Group	42.7 ± 8.1	31.1 ± 6.5	−11.6	3.94	.004

The experimental group experienced a statistically significant decline in AST levels (p = .004), reflecting reduced hepatic inflammation. The control group changes remained non-significant.

Table no.6 shows Changes in Alkaline Phosphatase (ALP, U/L)

Group	Pre-Test Mean ± SD	Post-Test Mean ± SD	Mean Difference	t-value	p-value
Control Group	119.8 ± 17.4	114.9 ± 16.8	−4.9	1.44	.183
Experimental Group	121.5 ± 18.6	103.1 ± 14.9	−18.4	4.11	.003

ALP levels declined significantly in the experimental group (p = .003), indicating enhanced biliary and hepatic function. The control group showed no statistically significant improvement.

Table no.7 shows Between-Group Comparison of Post-Intervention Outcomes

Variable	Control Group Mean ± SD	Experimental Group Mean ± SD	t-value	p-value
BMI (kg/m²)	28.9 ± 2.2	27.7 ± 1.9	2.21	.041
Uric Acid (mg/dL)	6.3 ± 0.7	5.6 ± 0.7	3.02	.007
ALT (U/L)	44.2 ± 8.3	33.9 ± 7.1	3.14	.006
AST (U/L)	39.8 ± 7.6	31.1 ± 6.5	2.79	.011
ALP (U/L)	114.9 ± 16.8	103.1 ± 14.9	2.46	.024

Post-intervention comparisons revealed statistically significant advantages for the experimental group across all outcome variables. These findings confirm the additive and synergistic benefits of resistance training combined with vitamin supplementation in improving metabolic and hepatic health.

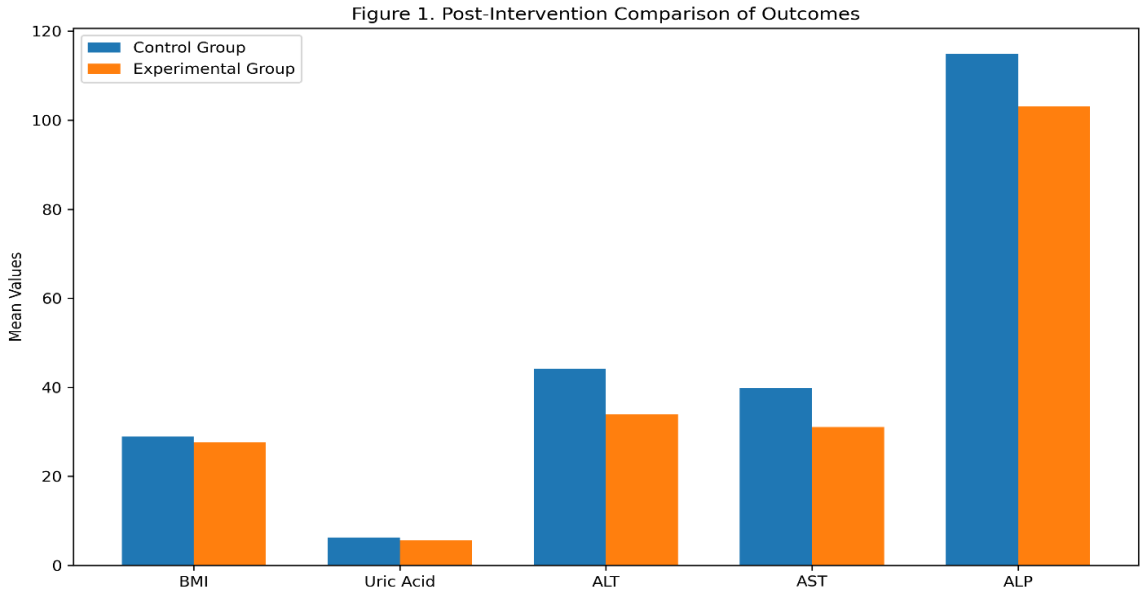

Fig 1 Illustrates Post-intervention differences between groups across all outcome variables

DISCUSSION

The current randomized controlled experimental trial examined the interactive effects of weight training and vitamin supplementation among females with non-alcoholic fatty liver disease (NAFLD) as per the levels of serum uric acid, liver enzyme, and anthropometric measures. The main results indicate that eight weeks of combined interventions provoked great improvements in serum uric acid (SUA), alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP) and the body mass index (BMI) when compared to the control group of regular activity. The results of this study give new experimental data in favor of the integrated lifestyle-based approach towards the metabolic and hepatic management of NAFLD within female populations.

Among the most glaring findings of this research was the reduction in the levels of serum uric acid which greatly deflated in the experimental group. Hyperuricemia has become widely identified as an indicative marker and a contributing pathogenic factor in NAFLD development by the mechanisms of oxidative stress, endothelial dysfunction, and hepatic lipogenesis (Jensen et al., 2018; Heyens et al., 2021). The degree of reduction in SUA in the current study is more significant than that of work interventions alone, implying that there is a combined effect of resistance training and vitamin supplementation. Resistance exercise increases skeletal muscle insulin sensitivity and uptake of glucose, thus suppressing hepatic de novo lipogenesis and purine turnover, which leads to (puric) acid production (Xu et al., 2019). At the same time, vitamins, especially vitamin C and vitamin D, have been found to raise the rate of renal uric acid secretion and reduce systemic inflammation (Godoy-Matos et al., 2020; Naska et al., 2023). A combination of these mechanisms is probably one of the reasons why the experiment group exhibited an intense uric acid reducing effect.

The alteration of ALT, AST, and ALP levels was significant after the intervention, showing an increase in the integrity of the hepatocellular and decreased hepatic inflammation. High levels of transaminases are common clinical indicators of liver damage and are highly linked with the severity of the disease in NAFLD (Younossi et al., 2019). The recorded reductions on liver enzymes are congruent with the recent experimental research that revealed that resistance training could decrease liver fat and inflammatory cues regardless of significant weight loss (Khan et al., 2021). Both vitamin E and Vitamin D contained in the supplement regimen have strong antioxidant and anti-inflammatory effects that safeguard the hepatocytes against oxidative causes (Abe et al., 2021). Earlier studies conducted by Butt and others have also shown exercise-induced changes in liver enzymes of physically active groups supporting the reproducibility compatibility of such results in different groups. This evidence is further developed by the present study to show similar benefits in a metabolically impaired population with NAFLD, represented by women.

Even though the BMI gains decreased significantly, the statistically significant reduction observed among the experimental group has significant clinical implications. It is not always necessary to drastically reduce weight to improve NAFLD; rather, body composition, muscle mass, and metabolic utility are becoming increasingly popular intervention outcomes (Le et al., 2022). Lean mass and visceral adiposity improve preferentially with resistance training over total body weight when establishing the lean mass, visceral adiposity is more important than total body weight in hepatic fat accumulation (Xu et al., 2019). The insignificant difference in BMI between the control group puts forward the low effectiveness of routine activity in itself and the importance of exercise interventions in a structured and supervised manner. Noteworthy, the positive changes in the biochemical profile were equally associated with the reductions in BMI, which could be viewed as the evidence of the idea that the overall metabolic health can be enhanced without the need to undergo massive weight loss.

The necessity to mention only females is a significant strength of this research. The sex-specific differences in uric kidney clearance, body fatty mass, and hormonal regulation are rather well-known and are underrepresented in NAFLD studies (Kosmalski, 2023). Lack of estrogen, especially in the peri- and post-menopausal women, increases the resistance to insulin and hepatic lipid remnants. The studies have revealed that resistance training to some degree neutralizes these effects by enhancing the disposal of glucose through muscle mediated processes as well as inflammatory balance. Moreover, the vitamin D and iron-related cofactors are more common in women and may have an indirect impact on hepatic and metabolic health due to micronutrient deficiency. The current results also provide that interventions

that would focus on both body activity and nutritional sufficiency can be particularly helpful in patients with NAFLD female.

The current results are in line with recent systematic reviews and meta-analyses that prove the effectiveness of resistance exercise to decrease liver fat and improve liver enzymes (Riazi et al., 2022). But little research has been conducted on the simultaneous study of serum uric acid as a primary outcome with a specific eye on the female population. This study adds to the comprehensive understanding of the metabolic processes of NAFLD progression and treatment through the incorporation of uric acid with the traditional hepatic parameters. Besides, the past experimental efforts by Butt et al. and Khan et al. that are aimed at exercise-induced biochemical modulation offer a solid methodological backbone of the current study and this makes its external validity more robust in the sphere of exercise physiology and sports science.

PRACTICAL AND ATHLETIC IMPLICATIONS

In a pragmatic sense, the findings have serious clinical exercise prescription implications as well as sports rehabilitation, and preventive health programs. The resistance training is affordable, easy to get and can be made to suit all levels of fitness thus it is a fitting intervention among NAFLDs. Together with specific vitamin provision, it provides a non-pharmacological approach which reduces drug addiction and side effects. In active women or female athletes with subclinical hepatic dysfunction, this intervention can be used as a treatment and symptom-enhancing method because it improves the efficiency of metabolism and decreases the level of systemic inflammation.

LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

Although it has strengths, the study has a number of weaknesses. The small sample size reduces the ability to generalize; however, randomized controlled design and similarity of effects increase the internal validity. The intervention was only eight weeks; there is a need to conduct more studies that can substantiate the long-term sustainability of benefits and effects of interventions on liver fat, which can be measured using the imaging modalities. Future studies need to use bigger multicenter studies, dose response relationships related to the use of vitamin supplementation, as well as the use of mechanistic biomarkers like insulin resistance indices, inflammatory cytokines, and oxidative stress biomarkers. Further, the comparative discussions of aerobic, resistance, and combined training modalities would additionally improve the prescription of exercises in NAFLD.

CONCLUSION

Based on data analysis and findings, the researcher arrived at the conclusion that a combination of eight weeks of the intervention consisting of resistance training and vitamin supplementation would have significant effects on uric acid regulation and liver functioning in women with NAFLD. These results endorse integrated lifestyle interventions as being safe, effective and scalable therapeutic means in metabolic liver disorders.

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