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Effects of high-intensity interval training on Fibrinogen, D-dimer and platelet count (PLT) in inactive men

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Original Research

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Abstract

Purpose: High-intensity interval training (HIIT) has become an increasingly popular exercise regimen due to its efficiency in improving cardiovascular health and metabolic function. Fibrinogen, D-dimer, and platelet count are key markers of coagulation and fibrinolysis, and their levels can indicate cardiovascular risk. This study aimed to investigate the effects of HIIT on fibrinogen, D-dimer, and platelet count in sedentary men, with the hypothesis that HIIT would reduce thrombotic risk factors. **Method:** A total of 24 healthy, sedentary Iranian men (aged 30-40 years) were randomly assigned to either a HIIT (n=12) or a control group (n=12). The HIIT group performed 10 weeks of HIIT, with 3 sessions per week, each consisting of 30 minutes alternating between 30 seconds of high-intensity exercise and 90 seconds of recovery. Blood samples were taken before and after the intervention to assess fibrinogen, D-dimer, and platelet count. Statistical analysis included paired t-tests and independent t-tests, with p-values <0.05 considered significant. **Results:** The HIIT group showed significant reductions in fibrinogen (p=0.025), D-dimer (p=0.032), and platelet count (p=0.041). Specifically, fibrinogen decreased from 292.5±38.4 mg/dL to 270.4±34.1 mg/dL, D-dimer from 0.72±0.10 µg/mL to 0.55±0.09 µg/mL, and platelet count from 238±31 × 10^3/µL to 221±29 × 10^3/µL. In contrast, the control group showed no significant changes in these markers (p>0.05). The HIIT group also showed significantly better results compared to the control group (fibrinogen p=0.025, D-dimer p=0.032, platelet count p=0.04). **Conclusion:** HIIT significantly reduced thrombotic risk markers in sedentary men, suggesting its potential to improve cardiovascular health by modulating coagulation and fibrinolysis. The observed effects highlight HIIT as an effective strategy for reducing cardiovascular risk factors, particularly in inactive populations. Further research with larger samples and diverse populations is needed to confirm these findings and explore long-term impacts.

Keywords: High-Intensity Interval Training (HIIT), Fibrinogen, D-dimer, Platelet Count.

Introduction

High-intensity interval training (HIIT) has gained considerable attention in recent years as an efficient and effective exercise regimen for improving cardiovascular health, reducing body fat, and increasing physical fitness. This type of exercise involves alternating short periods of high-intensity activity with periods of low-intensity recovery, making it an attractive option for individuals with limited time for exercise (Gibala & Ballantyne, 2007; Meyer et al., 2013). HIIT has been shown to provide cardiovascular benefits comparable to traditional moderate-intensity continuous training (MICT), particularly in improving metabolic risk factors (Wisløff et al., 2007). Furthermore, HIIT is highly efficient and allows for significant improvements in fitness in shorter periods of time (Jafari et al., 2021).

Fibrinogen is a soluble protein in the blood that plays an important role in the blood clotting process. This protein, produced in the liver, is converted to fibrin during injury and helps form blood clots (Ernst, 1993). Elevated fibrinogen levels are associated with an increased risk of thrombotic events, including heart attacks and strokes (Sackett, 2020; Stratton et al., 1991). Several studies have shown that exercise, particularly HIIT, can reduce fibrinogen levels and improve the balance between coagulation and fibrinolysis (Womack et al., 2006). In type 2 diabetic patients, HIIT significantly reduced fibrinogen levels, suggesting that this exercise may reduce cardiovascular risk by improving coagulation status (Rezaeimanesh, 2020). Similar results were observed in overweight individuals who performed HIIT, indicating improved fibrinogen metabolism (Jafari et al., 2021).

D-dimer, a fibrin degradation product, is another key marker used to assess coagulation and fibrinolysis. Elevated D-dimer levels indicate recent clot formation and subsequent fibrin degradation, which is indicative of increased coagulation activity (Kosuta et al., 2024; Womack et al., 2006). Studies have shown that acute bouts of HIIT can temporarily increase D-dimer levels, indicating increased coagulation activity (Gibala and Ballantyne, 2007). However, the long-term effects of HIIT on D-dimer and its relationship to fibrinolysis are not yet fully understood (Kosuta et al., 2024). Other research has shown that regular HIIT can regulate D-dimer levels and contribute to better fibrinolytic activity and overall cardiovascular health (Wisløff et al., 2007; Meyer et al., 2013). Platelet count is also a critical factor in assessing coagulation risk. Platelets play a critical role in blood clot formation, and increased platelet counts can increase the risk of thrombosis and lead to cardiovascular events (Ahmadizad and Al-Sayed, 2003; Jafari et al., 2021). Research has shown that exercise, particularly HIIT, can positively affect platelet activity by modulating platelet aggregation and activation (Kurdi et al., 2022). Studies have observed reduced platelet counts and improved platelet function after HIIT sessions, suggesting that HIIT may help reduce the risk of clot formation and cardiovascular complications (Kosuta et al., 2024). Furthermore, HIIT has been shown to reduce platelet aggregation, supporting its potential cardiovascular benefits (Kurdi et al., 2022; Sakett, 2020).

Overall, available studies suggest that HIIT can significantly affect coagulation factors and fibrinolysis. However, the variability in study results highlights the need for further research to better understand how these factors respond to HIIT, particularly in inactive individuals and those at risk for cardiovascular disease (Kosuta et al., 2024). This study aimed to provide valuable insights into the effects of HIIT on fibrinogen, D-dimer, and platelet count, and to provide a deeper understanding of the mechanisms by which HIIT may reduce cardiovascular risk in sedentary individuals (Jafari et al., 2021; Sackett, 2020). Therefore, the aim of this study was to investigate the effect of high-intensity interval training on fibrinogen, D-dimer, and platelet count (PLT) in inactive men.

Methods

Participants

The study recruited 24 healthy, sedentary Iranian men, aged between 30 and 40 years, with no history of cardiovascular diseases or other chronic illnesses. The participants were selected based on the following inclusion criteria: (1) not engaging in regular physical activity (less than 150 minutes of exercise per week for the last 6 months), (2) no signs of hypertension or diabetes, (3) absence of any acute medical conditions, and (4) BMI between 18.5 and 30 kg/m². Prior to participation, each subject provided informed consent, and the study protocol was approved by the ethical review board of the relevant institution.

Design and Procedure

This study employed a pre-post experimental design. Participants were randomly assigned to either a HIIT group (n=12) or a control group (n=12). The HIIT group engaged in 10 weeks of high-intensity interval training, consisting of 3 sessions per week, each lasting approximately 30 minutes. Each session included 5-minute warm-ups, followed by 20 minutes of alternating 30 seconds of high-intensity effort (85–90% maximum heart rate) and 90 seconds of low-intensity recovery, and ending with 5 minutes of cool-down. The control group maintained their sedentary lifestyle with no exercise intervention during the study period.

Biological Measurements

Blood samples were collected from all participants at baseline (pre-intervention) and immediately after the last training session (post-intervention) to measure fibrinogen, D-dimer, and platelet count. Fibrinogen was assessed using an enzyme-linked immunosorbent assay (ELISA) kit (Sigma-Aldrich). D-dimer was measured by using a commercial D-dimer assay (Biomerieux, France). Platelet count was determined by a complete blood count (CBC) test performed on a hematology analyzer (Sysmex, Japan). All samples were collected in the morning after a 12-hour fasting period and analyzed within 24 hours to ensure the accuracy of the results.

Statistical Analysis

Data were analyzed using SPSS version 26.0. Descriptive statistics, including means and standard deviations, were calculated for all variables. Paired t-tests were used to compare pre- and post-intervention values for fibrinogen, D-dimer, and platelet count within each group. Independent t-tests were performed to compare the changes between the HIIT and control groups. A significance level of $p < 0.05$ was set for all tests. Additionally, effect sizes (Cohen's d) were calculated to assess the magnitude of changes between pre- and post-intervention measurements.

Table 1: Anthropometric Characteristics of Participants

Variable	HIIT (Mean & SD)	Control (Mean &SD)
Age (years)	34.1 ± 4.2	33.9 ± 4.1
Height (cm)	175.0 ± 6.0	174.5 ± 5.8
Weight (kg)	80.0 ± 6.5	79.8 ± 7.2
BMI (kg/m²)	26.1 ± 2.1	26.4 ± 2.3
Waist Circumference (cm)	91.2 ± 5.1	91.5 ± 4.9
Hip Circumference (cm)	101.0 ± 6.0	100.8 ± 5.5
Body Fat Percentage (%)	23.5 ± 3.0	23.9 ± 3.2

Results

Participant Characteristics

The HIIT group demonstrated significant changes in all measured hemostatic markers from pre- to post-intervention. Specifically, fibrinogen levels significantly decreased from 292.5±38.4 mg/dL at baseline to 270.4±34.1 mg/dL after 10 weeks of HIIT ($p=0.025$). Similarly, D-dimer levels showed a significant reduction from 0.72±0.10 µg/mL to 0.55±0.09 µg/mL ($p = 0.032$). Platelet count also significantly decreased from $238 \pm 31 \times 10^3$/µL to $221 \pm 29 \times 10^3$/µL ($p=0.041$).

In contrast, the control group showed no significant changes in fibrinogen, D-dimer, or platelet count ($p>0.05$ for all comparisons). Fibrinogen remained at 289.1±35.7 mg/dL, D-dimer at 0.70±0.11 µg/mL, and platelet count remained unchanged at $239 \pm 30 \times 10^3$/µL.

When comparing the HIIT group to the control group, significant between-group differences were observed in all three variables. The HIIT group showed a greater reduction in fibrinogen (HIIT: 270.4±34.1 mg/dL vs. Control: 289.1±35.7 mg/dL, $p=0.025$), D-dimer (HIIT: 0.55±0.09 µg/mL vs. Control: 0.70±0.11 µg/mL, $p=0.032$), and platelet count (HIIT: $221 \pm 29 \times 10^3$/µL vs. Control: $239 \pm 30 \times 10^3$/µL, $p=0.04$).

These results suggest that HIITeffectively reduces thrombotic risk markers in inactive Iranian men, with a moderate to large effect size observed for fibrinogen ($d=0.58$), D-dimer ($d=0.65$), and platelet count ($d=0.53$).

Table1: Results of HIIT on Fibrinogen, D-dimer, and Platelet Count, Before and After with Effect Sizes (Cohen's d)

Variable	Group	Before(Mean & SD)	After (Mean&SD)	p-Value(Cohen's d)
Fibrinogen (mg/dL)	HIIT	292.5 ± 38.4	270.4 ± 34.1	**0.025**(0.58)
	Control	289.1 ± 35.7	288.2 ± 32.4	0.546
p-Value	-	0.365	**0.021**	-
D-dimer (µg/mL)	HIIT	0.72 ± 0.10	0.55 ± 0.09	**0.017**(0.65)
	Control	0.70 ± 0.11	0.71 ± 0.23	0.745
p-Value	-	0.526	**0.019**	
Platelet Count (×10^3/µL)	HIIT	238 ± 31	221 ± 29	**0.045**(0.53)
	Control	239 ± 30	238 ± 33	0.652
p-Value	-	0.425	**0.034**	-

Bolded numbers indicate significance levels.

Discussion

High-Intensity Interval Training (HIIT) has been increasingly recognized for its ability to improve various cardiovascular and metabolic health markers. This exercise modality, characterized by short bursts of intense exercise followed by periods of low-intensity recovery, has been shown to affect several hemostatic factors, including fibrinogen, D-dimer, and platelet count. Previous studies have suggested that exercise interventions, particularly HIIT, can positively influence blood coagulation and fibrinolysis systems, which are critical for maintaining cardiovascular health (Kosuta et al., 2020; Rezaeimanesh, 2020). This study aimed to explore the effects of a 10-week HIIT program on these markers in inactive Iranian men. The findings indicate significant reductions in fibrinogen, D-dimer, and platelet count following HIIT, suggesting a potential benefit for reducing thrombotic risks in this population.

The study found a significant reduction in fibrinogen levels in the HIIT group. These results are consistent with studies that have shown a decrease in fibrinogen levels following exercise interventions. For instance, Womack et al. (2006) demonstrated that both moderate and high-intensity exercise could reduce fibrinogen levels, which plays a key role in blood clot formation. This is especially significant in sedentary populations, where elevated fibrinogen is a known risk factor for cardiovascular diseases. However, some studies suggest that the reduction in fibrinogen may vary depending on the type, intensity, and duration of exercise. For example, Strauss et al. (2018) found that moderate-intensity exercise produced less of a reduction in fibrinogen compared to HIIT. In the present study, HIIT showed significant promise in reducing fibrinogen, potentially enhancing fibrinolytic activity and reducing clot formation.

Similarly, D-dimer levels also decreased significantly in the HIIT group, indicating a positive effect of HIIT on fibrinolytic activity. These results align with previous research, such as that by Gibala et al. (2007), who reported that high-intensity exercise triggers fibrinolysis, leading to a reduction in D-dimer as a marker of clot breakdown. Conversely, other studies, like those by Belviranli and Göktepe (2017), found that acute bouts of exercise could initially increase D-dimer levels, though these levels generally return to baseline after rest. The current study's findings suggest that while D-dimer may be transiently elevated after intense exercise, long-term HIIT effectively reduces D-dimer, likely due to improved fibrinolytic activity over time.

In this study, the platelet count in the HIIT group significantly decreased, which is consistent with findings by Ahmadizad and El-Sayed (2003), who observed that exercise reduces platelet aggregation. Platelets play a central role in thrombus formation, and their activity can be modulated by exercise. Several studies support the hypothesis that exercise, particularly HIIT, can decrease platelet count and improve platelet function. However, a study by Schmidt et al. (2019) reported no significant changes in platelet count following exercise, suggesting that the effect of exercise on platelets may vary depending on the individual's baseline health status and exercise type. The current study, however, demonstrates that consistent HIIT reduces platelet count and reactivity, thereby lowering the risk of thrombus formation in inactive men.

While the results of this study are promising, there are several limitations to consider. First, the small sample size (n=12 per group) may limit the generalizability of the findings to a larger population. Future studies should include a larger and more diverse sample to better understand the impact of HIIT on coagulation and fibrinolysis across different demographic groups. Additionally, the study focused solely on inactive Iranian men, and it would be beneficial to explore how these findings may apply to women, older adults, and individuals from different ethnic backgrounds.

Another limitation is the short duration of the intervention (10 weeks). Long-term studies are needed to assess whether the effects of HIIT on thrombotic risk factors are sustained over time. Moreover, while this study investigated only a few key markers, future research should explore a wider range of coagulation and fibrinolytic factors, as well as inflammatory markers, to fully understand the mechanisms through which exercise impacts blood clotting and fibrinolysis. Finally, comparing the effects of HIIT with other forms of exercise, such as resistance training, would provide a more comprehensive view of the benefits of different exercise modalities for improving thrombotic risk factors.

Conclusion

The results of this study demonstrate that high-intensity interval training (HIIT) has a positive impact on reducing thrombotic risk factors in sedentary men. Significant reductions in fibrinogen, D-dimer, and platelet count in the HIIT group indicate beneficial effects of this exercise modality on blood homeostasis and improved fibrinolytic activity. These findings align with previous studies that suggest intense exercise can reduce coagulation factors and help improve cardiovascular risk. Compared to the control group, the HIIT group showed not only significant changes in these markers but also moderate to large effect sizes, indicating the high effectiveness of HIIT in reducing thrombotic risk in inactive populations.

Although this study is limited to a small sample of sedentary Iranian men, its findings can serve as a basis for further research on the effects of HIIT on cardiovascular risk factors in different populations. To better understand the long-term impacts of such training, future studies should include larger sample sizes, longer intervention periods, and more diverse participant groups.

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Conflicts of Interest:

The authors declare no conflict of interest related to this study.

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