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Studying the Effect of a Period of Reduced Training Load (Tapering) on Blood Indices of Female Karatekas

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Abstract
Objective and background: In addition to being a recreational and invigorating activity, sports activities are considered an effective means of maintaining physical health and strength. The overall aim of the present study was to study the effect of a period of reduced training load on some blood indices (blood cells and hemoglobin) of female karatekas. Methods: The population consisted of 30 karatekas who had 5 years of sports experience, 14 of whom were randomly selected and divided into two control and experimental groups. 8 subjects were placed in the control group (regular sports activity), 8 subjects in the first experimental group (increasing resistance activity on the ergometer), 8 subjects in the second experimental group (increasing speed activity on the ergometer), and 8 subjects in the third experimental group (increasing power activity on the ergometer). The researcher took three milliliters of blood from the brachial vein from all subjects at the beginning and end of the training period before and after performing the Bruce maximum test on the ergometer, and the collected blood was transferred to the laboratory for analysis. Finally, the analysis of covariance test was used to compare the means in the four groups. Results: The results showed that white blood cells showed a level and based on the results of the Tukey post hoc test, a difference was observed between the mean scores of the control group with the first experimental group and the third experimental group ( ) and it was shown that there was no significant difference in the percentage of lymphocytes in any of the groups. Also, a significant difference in the level was not observed in the amount of monocytes in any of the groups under study. In the current study, a significant difference was observed in the amount of eosinophils in the first experimental group. This shows that in group 1, who performed increasing resistance exercises during the study period (overtraining), they had the most significant decrease in eosinophils in their blood. Research and Conclusion: Based on the findings of this study, it can be concluded that the most significant increase was observed in the number of white blood cells in the first experimental group, who performed increasing resistance exercises and the third experimental group who performed increasing power exercises, and in the first experimental group, in addition to a significant increase in leukocytes, a decrease in eosinophils was observed. This is also consistent with previous research that has shown that high training volumes and intensities in elite athletes affect their immune system, causing an increase in leukocytes (leukocytosis) and a decrease in blood eosinophils (eosinopenia), affecting their immune system and possibly weakening it.

Key words: *Tapering, Exercise training, Blood markers*.

Introduction

Tapering is a pre-competition training strategy that progressively and nonlinearly reduces training load to induce optimal athletic performance at the appropriate time of the season (1). Based on the positive (adaptations) and negative (fatigue) effects of training load on the human body (2), the goal is to reduce the negative effects and enhance the positive adaptations of training (3,4) by reducing training load to balance the opposing effects of cumulative fatigue and adaptations of training (5). Since 1985, when Castile et al. (6) first experimentally evaluated the effect of pre-competition training load reduction in swimmers, researchers have conducted numerous experimental studies in swimmers (7-9), cyclists (10,11), and runners (12,13) to confirm the effect of pre-competition reduction in athletic performance based on the physiological and psychological factors affecting such performance and to explore reduction strategies for different sports. The key to pre-competition tapering as a common strategy for improving performance in endurance athletes is the integration of a scientific arrangement of training variables such as training intensity, volume, frequency, burst duration, and burst type (1,14). Most studies confirm that pre-competition tapering strategies can improve athletic performance (15–18). However, researchers disagree about which variables should be changed and by how much. Jaffer et al. (19) found that a 50% reduction in training volume significantly improved performance in long-distance runners. However, some studies have concluded that training volume must be reduced even further, by at least 60%, to significantly improve athletic performance in endurance athletes in competition (20). Furthermore, few studies have altered pre-competition training load by decreasing intensity (10,21). These studies vary widely in the duration of the taper, ranging from 7 to 28 days. Most studies have used a period of 8–14 days (22), but some have used shorter (≤ 7 days) (23) or longer (> 28 days) (24). However, all of these tapering periods can have positive training effects for competitive sports. In addition, types of tapers, including step and progressive tapers, have been shown to be effective (25), but progressive tapering appears to be more successful (26). In summary, the methods of pre-competition training load reduction in the aforementioned studies vary considerably, and it is still unclear which taper is better at improving performance in endurance athletes. Previous meta-analyses (249 swimmers, 80 road cyclists, and 110 track runners) confirmed the benefits of reducing pre-competition training load on improving athletic performance and suggested that a 14-day period, with no change in training intensity or frequency, but with training volume progressively reduced by 41–60% (27). Despite this meta-analysis evaluating the effects of changes in taper components on performance in competitive athletes, a limitation is that the study focused not only on endurance athletes but also on sprinters. We did not perform a comparative analysis of the type of sporting event reported, and therefore the authors cannot make recommendations. provide more specific information about endurance sports. Given sport-to-sport and athlete-to-athlete differences, these findings may not accurately reflect the characteristics of tapering for endurance sports. Although the effects of tapering in endurance competition have received much attention over the past decade (13,22,28–31), it has been difficult for athletes, coaches, and researchers to identify tapering strategies that enhance performance in endurance athletes. Previous systematic reviews have helped to clarify the effects of tapering strategies on competitive performance (30,32), and nutritional, hydration, and recovery strategies during pre-competition tapering (30). However, these reviews have focused on conventional measures used to assess specific sports and aerobic capacities, such as maximal oxygen uptake and time to exhaustion, that determine endurance performance (33–38). These limitations have a significant impact on how tapering measures are interpreted to provide evidence-based training interventions for endurance athletes. Therefore, it is very difficult for athletes, coaches, and researchers to identify appropriate reduction strategies to enhance performance in endurance athletes. It seems necessary to conduct a systematic review and meta-analysis of the literature on the effect of reduction on endurance performance. The overall aim of the present study was to investigate the effect of a period of reduction in training load on physical performance (anaerobic power, aerobic power, and average power) and some blood parameters (blood cells and hemoglobin) of female karatekas.

Methods

Subjects

The population consisted of 30 karatekas who had 5 years of sports experience, from which 14 karatekas were randomly selected and divided into two control and experimental groups.

Data collection method

In order to select the subjects, the Golestan Province Championship Database (Gorgan City) was first referred to and the names of the athletes were received. Notices were sent to inform and invite those interested in participating in this study. After a week, the names of the volunteers, which were 90 people, were determined. 70 of these volunteers practiced karate, and 50 of the samples had championship titles. The researcher selected the subjects from among 50 karate volunteers to ensure homogeneity of the samples. Then, 32 subjects were selected from them by simple random selection. 8 subjects were placed in the control group (regular sports activity), 8 subjects in the first experimental group (increasing resistance activity on the ergometer), 8 subjects in the second experimental group (increasing speed activity on the ergometer), and 8 subjects in the third experimental group (increasing power activity on the ergometer). The subjects were placed in The age group was 15 to 25 years old and the average height of the subjects was 169 cm. The subjects generally did not use exercise bikes but were physically active regularly. Considering that the aim of this study was to study the effect of three overtraining methods on the immune system of skilled male karatekas, the researcher Manipulation of independent variables (three methods of physical activity up to the stage of overtraining on an exercise bike) studied their effect on dependent variables (leukocytes, lymphocytes, monocytes, neutrophils, and eosinophils).

On the first day, after providing sufficient explanation about the method of conducting the test and selecting samples from among eligible volunteers, and familiarizing them with the devices and how to use the ergometer (bicycle ergometer), the program of attendance and participation in the exercises was explained to them. In addition, they were reminded that for height and weight measurement, they should be without clothes and not take any medicine or food for four hours before the test, not be active, and have emptied urine and feces. It is worth noting that all blood samples were taken between 7:00 AM and 12:00 AM and from the brachial vein. On the second day, after completing the descriptive characteristics form and the PAR-Q questionnaire, the researcher took three milliliters of blood from the brachial vein from all subjects at the beginning and end of the training period before and after performing the Bruce maximum test on the ergometer, and the collected blood was transferred to the laboratory for analysis. In addition, a sheet was provided to the subjects to record their resting heart rate every morning, body weight in the morning, and the amount of sleep during the day and provide it to the researcher. Vo2max is a measurement of the practical capacity of the oxygen machine with the cardio-respiratory system. This measurement is the only accurate indicator of the initial fitness level of each subject.

Statistical analysis

After extracting the data of this study through descriptive statistics (mean, standard deviation, drawing tables and graphs, maximum and minimum), the analysis of covariance test was used to compare the means in four groups. To compare the differences between the pre-test and post-test means in each group, the paired difference comparison test was used, and if there was a difference, the Tukey post-hoc test was used, which considered the significance level of the tests.

Research results

Descriptive statistics of the demographic and anthropometric indicators of the subjects in the experimental and control groups are presented in Table 1.

Table 1: Comparison of average age, height, weight, and championship history in the two groups

championship history		weight		height		Age		Groups
deviation from the standard	Averag	deviation from the standard	Averag	deviation from the standard	Averag	deviation from the standard	Averag	Control
0/97	2/4	5/9	65	0/6	1/70	2/49	18/7	
1/8	3/6	8/8	70	0/94	1/67	2/4	18/8	Test

Based on the table above, it shows that the highest average age was in the second experimental group with an average of 19.2 and the lowest in the control group with 18.7. The highest average height was in the third experimental group with 1.71 and the lowest in the first experimental group with 1.67, the highest average weight was in the third experimental group with 73.3 and the lowest in the control group with 65, the highest average championship record was in the third experimental group with 4 and the lowest in the control group with 2.4.

Table 2 shows the comparison of the distance traveled on the ergometer before and after training in the four groups.

Table (2) Comparison of the distance traveled on the ergometer before and after training in the four groups

After training		Before training		Groups
deviation from the standard	Average	deviation from the standard	Average	Control
0/59	3/53	0/69	3/97	
0/44	3/44	0/53	3/91	First Experimental
0/19	3/67	0/48	3/88	Second Experimental
0/18	3/63	0/70	4	Third Experimental

As the table above shows, the highest and lowest average distance traveled in kilometers before training was 3.67 for the second experimental group and 3.44 for the first experimental group, and 4 for the third experimental group and 3.88 for the second experimental group, respectively (Figure 1).

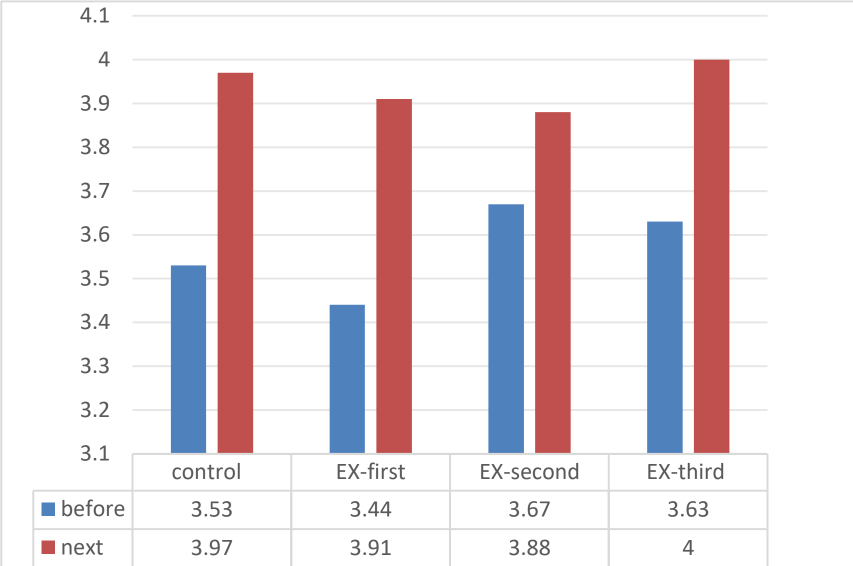

Chart (1) Comparison of average distance traveled on the ergometer before and after training in four groups Table 4 shows the average activity time on the ergometer before and after training in the four groups.

Table (3) Comparison of average activity time on the ergometer before and after training in four groups

After training		Before training		Groups
deviation from the standard	Average	deviation from the standard	Average	Control
2/12	13/58	2/04	13/90	
1/92	13/42	2/16	13/82	First Experimental
0/00	13/55	1/97	13/97	Second Experimental
0/29	13/50	2/36	14	Third Experimental

As shown in Table 3, the highest and lowest average activity time in minutes before exercise was for the control group with 13.58 and the first experimental group with 13.82, respectively, and after exercise was for the third experimental group with 14, and the lowest was for the first experimental group with 13.90 (Figure 2).

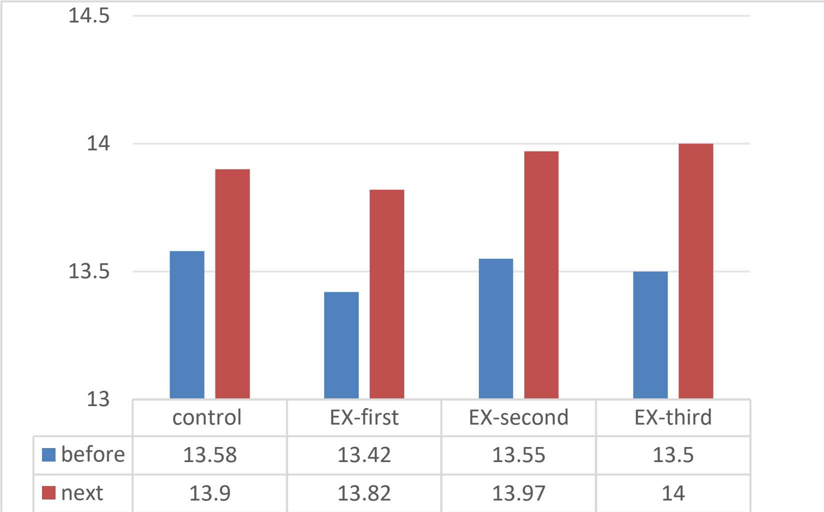

Chart (2) Comparison of mean activity time on the ergometer before andafter training in four groups

Table 4 shows the mean before and after training in the four groups.

Table (4) Comparison of the mean before and after training in the four groups

After training		Before training		Groups
deviation from the standard	average	deviation from the standard	average	Control
15/19	83/18	15/68	85/25	
19/52	91/52	21	96/16	First Experimental
13/63	84/39	19/95	91/80	Second Experimental
18/99	75/9	32/12	78/22	Third Experimental

As shown in Figure 3 and Table 4, the highest average oxygen consumption in liters per minute before exercise was for the first experimental group with 91.52 and the lowest was for the third experimental group with 75.90. After exercise, the highest average was for the first experimental group with 97.16 and the lowest was for the third experimental group with 82.22.

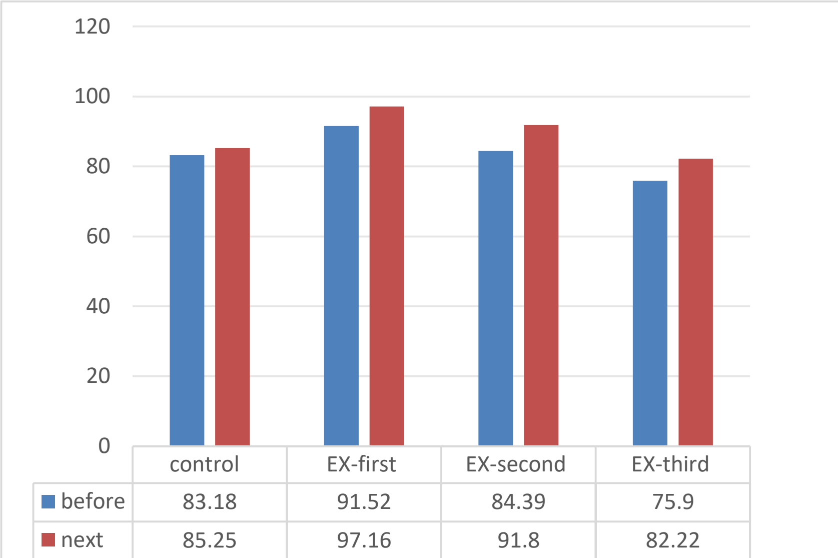

Chart (3) Comparison of the mean before and after exercise in the four groups

Table 5 shows the calories consumed before and after exercise in the four groups.

Table (5) Comparison of average calorie consumption before and after exercise in four groups

After training		Before training		Groups
deviation from the standard	Average	deviation from the standard	Average	Control
22/69	84/57	23/78	94/14	
22/23	81	33/43	100/5	First Experimental
13/47	80/5	20/28	91/75	Second Experimental
3/16	85	29/14	123/2	Third Experimental

As shown in Figure 4 and Table 5, the highest and lowest average calorie consumption in terms of kilocalories before exercise was for the third experimental group with 85 and the second experimental group with 80.5, and after exercise was for the third experimental group with 123.2 and the second experimental group with 91.75, respectively.

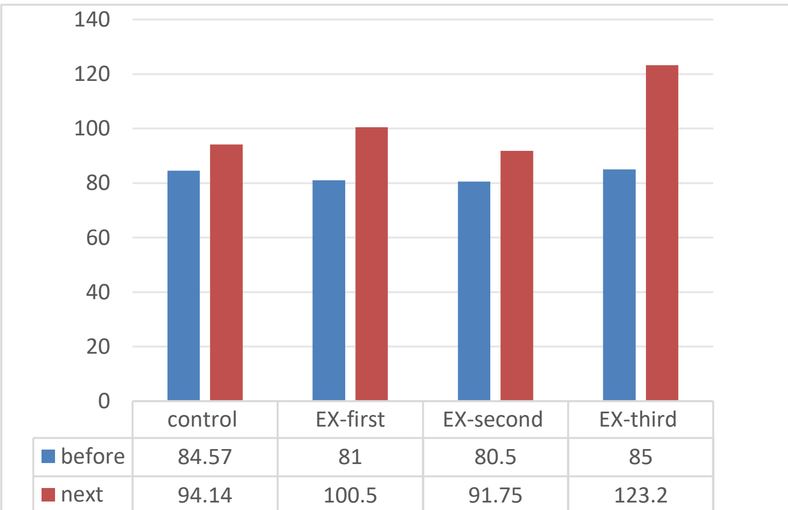

Figure 4 Comparison of mean calorie consumption before and after training in four groups

Analysis of covariance was used to investigate the effects of tapering on blood indices of female karatekas. Table 6 shows descriptive statistics of leukocytes in all four groups studied.

Table 6 Comparison of leukocyte mean in four groups according to four types of tests

standard deviation	Average	Groups	Test type
1/02	5/87	Control	First
0/90	5/92	First Experimental	Second
0/87	6/31	Second Experimental	
1/15	5/85	Third Experimental	
0/82	7/95	Control	Third
1/75	8/37	First Experimental	First
0/86	7/93	Second Experimental	
1/43	9/06	Third Experimental	
0/97	7/80	Control	
2/5	7/27	First Experimental	Second
0/88	6/46	Second Experimental	Third
0/74	5/91	Third Experimental	
1/62	6/70	Control	
1/64	7/90	First Experimental	
0/99	7/46	Second Experimental	
1/20	7/36	Third Experimental	

As Table 6 shows, the range of mean leukocyte counts in the first test in the four groups was between 5.85 and 6.31, in the second test between 7.93 and 9.06, in the third test between 5.91 and 7.80, and in the fourth test between 6.7 and 7.8.

The mean leukocyte counts after the first test are given in Table 7.

Comparison table of mean leukocyte counts in the first post-test in four groups

standard deviation	Average	Groups
0/971	**7/080**	Control
2/56	**7/27**	First Experimental
0/88	**6/46**	Second Experimental
0/74	**5/91**	Third Experimental

As the table above shows, the highest mean is for the first experimental group with 7.27 and the lowest mean is for the third experimental group with 5.91.

Table 8 shows the analysis of covariance comparing the mean leukocytes in the four groups.

Table 8 Analysis of covariance comparing leukocyte mean in four groups

Power	Eta	*Sig*	F	
/6710	**/3490**	**/0390**	**3/39**	Groups

Based on the findings in the table above, it was shown that there was a statistically significant difference in the mean leukocyte count in the three groups (P<0.05).

Based on the results of Tukey's test and paired comparison, it was shown that the difference between the mean leukocyte count in the control group and the first and third experimental groups was significant (P<0.05) (Table 9).

Significance level	Average difference	
0/031	**1/55**	Control
0/010	**1/87**	Experimental groups

Table 10 shows the average lymphocytes in four groups according to four types of tests.

Table 10 Comparison of average lymphocytes in four groups according to four types of tests

Deviation from the standard	Average	Groups	Test type
8/53	43/2	Control	First
10/62	38/2	First Experimental	Second
7/79	44	Second Experimental	
5/56	41	Third Experimental	
10/52	41/8	Control	Third
7/32	39/7	First Experimental	First
7/23	48	Second Experimental	
5/46	41	Third Experimental	
7/04	40	Control	
4/93	40/5	First Experimental	Second
8/23	39/6	Second Experimental	Third
5/95	40/3	Third Experimental	
10/79	41/0	Control	
12/97	43/7	First Experimental	
7/55	39/6	Second Experimental	
6/38	41	Third Experimental	

As Table 10 shows, the range of mean lymphocytes in the first test in the four groups fluctuated between 38.2 and 44, in the second test between 39.7 and 48, in the third test between 39.6 and 40.5, and in the fourth test between 39.6 and 43.7.

Comparison of mean lymphocytes after the first test in the studied groups is given in Table 11.

Deviation from the standard	Average	Groups
11/04	40	Control
4/93	40/500	First experimental group
8/23	39/66	Second experimental group
5/95	40/33	Third experimental group

As the table above shows, the highest mean lymphocyte count was in the first experimental group with 40.5 and the lowest was in the second experimental group with 39.66. The analysis of covariance comparing the mean lymphocyte count in the four groups is given in Table 12.

Table 12 Analysis of covariance comparing the mean of lymphocytes in four groups

Power	Eta	Sig	F
/089	0/038	0/859	0/252

Based on the findings of the table above, it was shown that there was a statistically significant difference in the mean lymphocytes in the three groups (P<0.05).

Table 13 shows the mean monocytes in the four groups according to the four types of tests.

Table 13 Comparison of mean monocytes in four groups according to four types of tests

Mean Standard	deviation	Groups	Test type
0/51	1/62	Control	First
0/50	2/25	First Experimental	Second
0/51	1/66	Second Experimental	
0/51	1/66	Third Experimental	
0/46	1/75	Control	Third
0/50	1/75	First Experimental	First
/40	2/16	Second Experimental	
0/51	1/66	Third Experimental	
0/46	1/75	Control	
0/50	2/25	First Experimental	Second
0/40	1/83	Second Experimental	Third
0/000	2	Third Experimental	
0/46	1/75	Control	
0/000	2/0	First Experimental	
0/000	2	Second Experimental	
0/000	2	Third Experimental	

As the table above shows, the range of mean monocytes in the first test in the four groups was between 1.62 and 2.25, in the second test between 1.66 and 2.16, in the third test between 1.75 and 2.25, and in the fourth test between 1.75 and 2. Also, the comparison of mean monocytes in the first post-test in the four groups is given in Table 14.

Table 14 Comparison of mean monocytes in the first post-test in four groups

deviation from the standard	Average	Groups
0/46	1/75	Control
0/50	2/25	First experimental group
0/40	1/83	Second experimental group
0/000	2	Third experimental group

As Table 14 shows, the highest mean monocyte count was in the first experimental group with 2.25 and the lowest mean was in the control group with 1.75. The covariance of the comparison of the mean monocyte count in the four groups is shown in Table 15.

Table 15 Analysis of covariance of the comparison of the mean monocyte count in the four groups

Power	Eta	Sig	F	Groups
0/185	0/109	0/552	0/776	

As the table above shows, there is no statistically significant difference between the mean monocytes in the four groups ($P<0.05$).

Table 16 shows the comparison of the mean neutrophils in the first post-test in the four groups and Table 17 shows the analysis of covariance comparing the neutrophils in the four groups.

Table 16 shows the comparison of the mean neutrophils in the first post-test in the four groups

standard deviation	Average	Groups
10/99	56/12	Control
5/32	54/50	First Experimental
7/9	56	Second Experimental
5/7	55/33	Third Experimental

The results of the analysis of covariance showed that there was no statistically significant difference between the mean neutrophils in the four groups ($P<0.05$).

Table 18 shows the comparison of the mean eosinophils in the four groups according to the four types of tests.

Table 18 Comparison of mean eosinophils in four groups according to four types of tests

deviation	Mean standard	Groups	Test type
0/51	2/37	Control	First
0/50	2/75	First experiment	Second
0/0	2	Second experiment	
0/51	2/33	Third experiment	
0/35	2/12	Control	Third
0/57	2/50	First experiment	First
1/22	2/50	Second experiment	
0/40	2/16	Third experiment	
0/0	2	Control	
0/50	2/75	First experiment	Second
0/54	2/50	Second experiment	Third
0/51	2/33	Third experiment	
0/35	2/12	Control	
0/95	2/75	First experiment	
0/000	2	Second experiment	
0/0	2	Third experiment	

As the table above shows, the range of mean eosinophils in the first test in the four groups fluctuated between 2 and 2.75, in the second test between 2.12 and 2.50, in the third test between 2 and 2.75, and in the fourth test between 2 and 2.75. Table 19 also shows the comparison of mean eosinophils in the

Table 19 Comparison of mean eosinophils in four groups at the first post-test

Deviation from the standard	Average	Groups
0/0	2	Control
0/50	2/7	First experimental group
0/54	2/50	First experimental group
0/51	2/33	Third experimental group

As the table above shows, the highest mean was for the first experimental group with 2.7 and the lowest mean was for the control group with 2. The analysis of covariance comparing the mean eosinophils after the second test in the four groups is given in Table 20.

Table 20 Analysis of variance comparing the mean eosinophil count after the second post-test in four groups

Power	Eta	Sig	F	Groups
0/690	0/385	0/35	3/53	

Covariance analysis showed that there was no significant difference between the mean eosinophil score in the four groups (P<0.05). While, based on the results of the Tukey test, the difference between the mean eosinophil score in the control group and the first experimental group was significant (Table 21).

Table 21 Pairwise comparison of mean difference in eosinophils according to study groups

Significance level	Average difference	Groups
0/006	-1/837	Significance level

Discussion and Conclusion In the present study, the results of the analysis of covariance test performed on the average of the four groups in the post-test showed a significant difference in the amount of white blood cells in the surface, and based on the results of the Tukey post-test, a difference was observed between the mean scores of the control group with the first experimental group and the third experimental group ( ). This shows that the experimental group 1, which performed increasing resistance exercises and the experimental group 3, which performed increasing power resistance exercises, had a significant increase in their white blood cells. The results of this study are consistent with the research of Cassetti (1998), Payne (1994), Nieman (1992), who reported that following 12 minutes of high-intensity exercise on a treadmill or an ergometer bicycle, the subjects experienced a significant increase in the number of leukocytes, and are inconsistent with the research of Galen (1987), Zardi (1379). In the present study, it was shown that no significant difference was observed in the percentage of lymphocytes in any of the groups. Overtraining does not appear to significantly alter lymphocyte counts. Kane (1995), Salami (2001), Gleason et al. (1995) found no change in total lymphocyte counts during a seven-month training season in elite swimmers, which is consistent with the results of this study. In contrast, Lind (1987), Fitzgerald (1991), and Niemann (1992) found an increase in lymphocytes following 12 minutes of high-intensity exercise on a treadmill or two cycles of ergometer exercise, which is inconsistent with the results of this study.

According to the results of this study, no significant difference in the level of monocytes was observed in any of the groups under study. This study is in contrast to the study of Tidball (1995), which observed a significant increase in the number of monocytes in runners after a period of aerobic running training. However, the study of Salami (2001) and McNion (1992) from the analysis of blood samples of swimmers who performed hard and increasing exercises did not observe a significant change in the level of monocytes in their blood, which is similar to the results of this study. Based on the results obtained in this study, no significant difference in the level of neutrophils was observed in any of the groups under study, which is inconsistent with the research (Boray (1995), McCarthy (1992), Shek (1995) that the number of neutrophils increases during and after all physical activities, but it is consistent with the research of Salami (1380) and Doster (1988) that the number of neutrophils in men with different physical fitness levels returned to pre-activity levels one hour after the treadmill test to the point of fatigue. Also, in the current study, a significant difference in the level of eosinophils was observed in the experimental group 1. This shows that in group 1, who performed increasing resistance training during the study period (overtraining), they had the most significant decrease in their blood eosinophils. The results of this study are consistent with the research of Nieman (1992), who found that three hours of endurance running with eosinopenia (decreased eosinophils) Eosinophils in the blood) are related during the recovery phase, eosinophils did not return to normal levels at 9 p.m. of the recovery phase, but this is consistent with Salami's research (2001).

This is in contrast to Miliji (1999), who reported that athletes have higher blood eosinophils during and after exercise than non-athletes, but this difference was not statistically significant. Wang et al. (2023) stated that load reduction combined with pre-load overload training appears to be more conducive to maximizing performance gains. Current evidence suggests that a ≤21-day taper, in which training volume is gradually reduced by 41–60% without changing intensity or frequency, is an effective tapering strategy. (39)

In the general population, adaptation to training appears to depend on factors such as training intensity, training volume and frequency, and initial fitness level. However, in highly trained athletes, training intensity and initial performance level appear to be the most important factors influencing the response to training and, consequently, competitive performance, provided that the required training volume and frequency are ensured. When preparing for a major competition, athletes tend to reduce their training load for a variable period of time. This technique, known as tapering, can have a significant impact on athlete performance. The response to a taper may be influenced by the degree of reduction in intensity, volume, and frequency of training, as well as the combined effects of these variables. A comprehensive review of the available literature suggests that if detraining is to be avoided, training volume and frequency can be reduced to a level above the training intensity. In addition, the duration of the reduction period and the time constant of the decay of the training load can also affect the response to a reduction in training load. In fact, gradual reductions appear to be more effective than standardized abrupt reductions in improving an athlete's performance level (40).

Divsalar et al. (2024) found that improvements in the 200-m swimming record were greater in TP than in CG (p<0.05). In addition, creatine phosphokinase, creatinine, urea, uric acid, and lactate dehydrogenase were significantly reduced after tapering (p 0.05). However, hematological factors did not show significant differences between groups. Furthermore, no significant correlation was found between swimming records and the measured parameters. These results indicated that 10 days of tapering could improve 200-meter swimming records and metabolic, but not hematological, profiles in young recreational swimmers (40). Fallah et al. (2023) investigated the effect of a tapering period with creatine supplementation on hormonal responses in male soccer players. The results showed that cortisol levels were significantly reduced in both groups at posttest compared to pretest (p≤0.05), while no significant difference was observed between testosterone and T/C (p≥0.05). There were also no significant differences in testosterone, cortisol, and T/C levels between the two groups. A taper can reduce cortisol levels in male athletes, but creatine supplementation had no significant effect on cortisol, testosterone, or T/C ratios during the taper. (41) A taper refers to a gradual reduction in training load prior to an athletic competition, with the goal of reducing fatigue while maintaining/increasing training adaptations (1). This reduction in fatigue and maintenance/increase in training adaptations has a significant impact on athletic performance, typically resulting in a 2–3% improvement (1). Although these changes are marginal,

However, in elite sport, a distinction is often made between finishing inside or outside the medal positions in major sporting events (2). Consequently, understanding and optimizing tapers is key to athletic success and has subsequently attracted considerable research attention (3, 4). Studies examining tapers have largely focused on identifying the optimal taper strategy or on identifying the variables underlying the performance-enhancing effects of tapers (3, 4). For example, a meta-analysis aimed at finding the optimal taper found that an 8- to 14-day gradual reduction in training volume of 41% to 60% while maintaining training intensity and frequency was best for most swimmers, runners, and cyclists (3). In addition, a range of physiological variables have been studied during tapers, including cardiorespiratory, metabolic, biochemical, hormonal, neuromuscular, and immune factors (4). Of these variables, the bar seems to be consistently associated with improvements in creatine kinase, testosterone, cortisol, and muscle strength and power, suggesting that these physiological variables underlie improved performance during decline (5,6,7).

Overall, the results of this study suggest that the most significant increases in white blood cell count were observed in experimental group 1, which performed incremental resistance training, and experimental group 3, which performed incremental power training, and that experimental group 1, in addition to a significant increase in leukocytes, also had a decrease in eosinophils. This is also consistent with previous research that has shown that high training volumes and intensities in elite athletes affect their immune system, causing an increase in leukocytes (leukocytosis) and a decrease in blood eosinophils (eosinopenia). and affect their immune system, possibly weakening it. As a result, it is better to conduct further research in this field and not use the training methods of the first and third groups for female karate champions, and to use lower intensity training with a longer recovery period. If an athlete shows two or three of the cases of overtraining mentioned in this study, it is better to refrain from activity and rest until complete recovery is achieved.

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