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ORIGINAL ARTICLE

Comparison of Physical and Physiological Effects of Continuous and Interval Running Training in Elite Adults

SERDAR BÜYÜKİPEKCİ[1], MUSTAFA SABIR BOZOĞLU[2]
[1]*Necmettin Erbakan University, Meram Vocational School, Konya/TURKEY*
[2]*Necmettin Erbakan University, Faculty of Tourism Head Of Department of Recreaiton Management KONYA/TURKEY*
Correspondence to: Mustafa Sabır BOZOĞLU, Email. sbuyukipekci@erbakan.edu.tr, Orcid: 0000-0003-2690-1053

ABSTRACT

Aim: It is known that endurance trainings increase physiological adaptations. However, knowledge on its effects on physical and motor performance is insufficient. Therefore, this study aims to compare the effects of 8-week continuous and interval endurance runs on physical and physiological performance in elite adults.

Material and Methods: A total of 18 adult male athletes between the ages of 19-25, consisting of continuous runs (CR) n:9 and interval group (IG) n:9, participated in the study. While the continuous running group (CR) was subject to the continuous running method 3 days a week for 8 weeks, interval running method was used for the other group. Experimental research model, including pre-test and post-test, was used in the study. Body weight measurement, 20-meters speed, vertical and horizontal jump, cooper, balance, sit-reach tests were applied to the athletes participating in the study before and after the training program. Variance and homogeneity of the obtained data were tested, and Independent Samples t test and Paired Samples t tests were used in the analysis of the data.

Results: After the interval and continuous running training programs, the change in body weight and Cooper test values before and after the interval training and continuous running groups were found to be statistically significant ($p<0.05$). It was observed that the changes in the standing long jump, speed, vertical jump, balance and sit-and-reach flexibility test values of the interval training group before and after the training were statistically significant ($p<0.05$) while the change in the continuous running group was not statistically significant. In addition, it was determined that there was a significant change in the balance post-test values in the interval training group compared to the pre-test values.

Conclusion: As a result, it shows that the interval and continuous running training programs applied have positive effects on body weight and endurance, and when interval training and continuous running training programs are compared, interval trainings can be efficient in terms of balance, flexibility, vertical and horizontal jump, and 20-meters speed performances.

Keywords: Endurance, Continuous runs, Interval Training, Motor Performance

INTRODUCTION

Training and is the process of ensuring adaptation of the organism by repeating the exercises in a systematic way [1,2,3,4,5]. For this reason, it should be noted that different impacts of training on the adaptation of the organism may vary depending on the scope, severity, frequency and duration of trainings. In addition, it is reported that athletes who possess training adaptation will develop in a shorter time and faster [1]. New training models are being researched and implemented in order to achieve successful performance in sports and to evaluate the preparation periods effectively [6]. In this sense, it is possible to optimize and adapt physical and physiological performance in sports with interval and continuous running training [7], however, the results about which method is effective are contradictory [8]. The conflicting situations that exist are often due to the variation in scope, duration and intensities of training that are inherently included in each program but are often not considered in detail. While continuous submaximal running training is effective on the body's oxygen transport system, high-intensity interval training has the greatest impact on the structural and biochemical properties of the muscle. Physiological basis of both forms of training is discussed and year-round trainings and training recommendations are made to increase the anaerobic threshold.

The main target in continuous running is to develop aerobic capacity in the organism. In the researches, fat metabolism is activated when long-term training and load intensity is low, while glycogen metabolism is activated in contrary trainings (short-term and high intensity) [9,10]. It has been reported in studies that physical and physiological characteristics of the organism are improved by training applied at least 3-5 days a week, between 20-60 minutes, with 50-85% maxVO2 intensity or 60-90% of maximum heart rate [11].

Interval running training is the systematic variation of rest or high and low load phases with the characteristic of repeating multiple exercise series at certain intervals [8]. It can be said that the interval endurance method can be used in terms of cardiac enlargement and at the same time improving carbohydrate metabolism, that is, aerobic and anaerobic capacity [9,10]. Interval running principle is a training method which was first described in 1959 by Reindell & Roskamm [12] that alternates between high and low-intensity exercise periods, and it has been reported to have positive effects on various parameters such as health, performance and motor characteristics for athletes [13,14,15].

Compared to continuous running, interval running allows the athlete to maintain a higher intensity and train longer at high intensities (>85% maximal heart rate (HRmax) [16,17]. In the interval training method, the effects may vary depending on the total workload, time, exercise intensity, resting time, resting intensity, and movement patterns [18,19]. Depending on the purpose of the training, these variables can be modified to provide countless

different combinations. Studies on athletes with high training adaptation indicate that the best training impact, namely increased loading volume and oxygen delivery, is achieved at intensities between 85-95% of HRmax [20,21], however each interval program has different effects on difficulty levels [19,22]. It has been stated that the optimal interval time of interval training for endurance athletes is 4-10 minutes [20,21] and the effective time is approximately 15 minutes. [16,20]. The optimal number of weekly high-intensity interval training sessions to maximize performance improvement has not yet been clarified.

Studies in the literature regarding interval and continuous running training have focused on the effects on the cardiovascular system, maximum oxygen consumption [23], heart rate volume, and body weight [24]. Due to the limited number of studies investigating the effects of interval and continuous running training on motor characteristics, the aim of this study is to examine the different effects of continuous and interval running training on physiological, physical and motor performance in elite adults.

MATERIAL AND METHODS

18 university student with an average age between 20-25, who do not exercise regularly have participated in the study voluntarily. Athletes participating in the study are randomly divided in to two groups as interval training (n:9) and continuous runs (n:9) training group. Both groups were subject to interval and continuous running training for 8 week. A running program suitable for the distance to be run and maximal heartrate value properties were applied within the scope of applied training methods [25]. Experimental research model, including pre-test and post-test, was used in the study. Balance, vertical and horizontal jump test, sit-and-reach flexibility and cooper aerobic capacity measurement tests were applied to the athletes participating in the study before and after the training. Athletes participating in the study were given detailed verbal and written information about the tests to be performed and signed a voluntary participation approval form. The study was carried out with athletes who did not experience any injuries in the last 6 months. During the training programs, verbal motivational support was provided in order to achieve the targeted performance. Particular attention was paid to warm-up and cool-down protocols and liquid consumption in order to avoid any disability or injury during the tests and training programs applied in the study.

Continuous Running Training Program: After determining the maximum heartrate of the athletes participating in the study; continuous training program was applied with 30% of the heartrate in approximately 5-6 km distance was week one adaptation training. In the following weeks, training intensity and duration were increased by 15-20% according to the maximum heart rate determined each week. In the determined training program, attention was paid to ensure that the maximum heart rate was between 50-70% [9].

Interval Training Program: interval training program has been prepared in accordance with short and medium-term interval methods.

Table 1:

Week	%-Time (min)	Characteristics	Purpose
1	50/ 50-60’	Tempo run	Adaptation

Table 2:

Week	%	time (min)	Warm-up	Stages End
2	40-50	10-12'slow tempo run and aerobic drills	200x1- 400x1- 800x1 active rest between series	10-15' cool down
3	40-50	10-12'slow tempo run and aerobic drills	200x1– 400x1 800x1 active rest between series	10-15' cool down
4	50-60	10-12' slow tempo run and skipping rope	200x2-400x2 800x2 active rest between series	10-15' cool down
5	50-60	10-12' slow tempo run and skipping rope	200x2-400x2 800x2 active rest between series	10-15' cool down
6	60–70	10-12' slow tempo run and skipping rope	400x2 -800x2-1000x2 active rest between series	10-15' cool down
7	60–70	10' 1200m tempo run	400x3-800x3- 1000x3- active rest between series	10-15' cool down
8	70-80	10-12' low tempo run	400x3-1000x2-1200x2-active rest between series	10-15' cool down

Measurement methods, Weight measurement: Weight measurement was made while the subjects were wearing jerseys and shorts, barefoot with an empty stomach. Weight measurements were made with Seca brand digital height and weight measurement device with an accuracy level of 100 grams.

Vertical jump test: For pre-test measurement, athletes were ask to stand upright, with the soles of their feet fully contacting the ground, extend their arms closer to the vertical jumping board fully upwards and the highest point was marked. Then, the subject was asked to touch the highest point he/she could reach, and the distance between the highest point he/she could reach by jumping and the point reached by the arm length was recorded in centimeters [26].

Standing long jump: Before the test, athletes participating in the study were asked to stand behind the marked line, with their legs bent at the back and their body slightly bent, and to jump to the farthest point where they could jump forward without moving their feet. The distance between the heels of the athletes and the starting line was recorded in centimeters. Athletes were given two attempts and their best results were recorded [27].

20-meters speed: Subjects ran between two lines determined in 20 meters in the hall using their maximal strength. Degrees in seconds were recorded with an Infitek brand photocell stopwatch. Athletes had two attempts and the best score was recorded. Full rest was provided between runs [9].

Sit-and-reach: In the study, flexibility measurement sit-and-reach flexibility test bench was used. Athletes were asked to take off their shoes and place their feet at the '0' reference point level. Measuring ruler was placed at 15 cm at the beginning of the test. During the measurement, the athlete's knees were pressed to prevent the athlete from bending their knees. Afterwards, the athlete was asked to reach farthest point he/she could reach by pushing the measuring board in a slow and controlled manner, without making intermittent impacts or sudden pushing movements. After staying at this point for 2 seconds, the distance reached was recorded in centimeters [28].

Cooper test: Athletes participating in the study were asked to run the maximum distance they can in 12 minutes. Lap times in each 400 meters were verbally reported to the athletes. Each 400 meter scores of athletes were recorded. When the 12-minute time is up the athletes were verbally warned and asked to stop. In addition, an observer was assigned for each athlete and it was ensured that they stopped the running athlete at the finish line. Laps ran by athletes were calculated, their distance to the start compared to the last lap was measured, and recorded in meters [28].

Balance test: It was measured with the flamingo balance test. Athletes were asked to stand on a 50 cm long, 4 cm high and 3 cm wide wooden balance beam and stand balanced on one foot, bend the other leg at the knee, pull it towards the hip, and hold the foot with their hand on the same side. While the athletes were in balance like this, the time was started and they were told to stand balanced for one minute. When the balance was disturbed, the time was stopped, and when the athlete regained his balance by climbing on the balance beam, the time was resumed from where it left off. The test was continued in this way for one minute and when the time was completed, each balance attempt of the athletes was recorded as a score [29].

Statistical Analysis: The homogeneity and variance of the data were tested. Independetsample t-test and PairedSamples t-test were used in the analysis of the data.

RESULTS

Table 1: Body weight

BodyWeight (kg)	N	X	Sd	Min	Max	Z	Asymp.sig (2-tailed
Int.Grup-1	9	71,44	12,40	58,00	93,00		
Int.Group-2	9	68,89	12,90	57,00	95,00	-2,203	,028*
Cont.R.Group-1	9	71,44	7,60117	63,00	85,00	-2,121[a]	
Cont.R.Group-2	9	70,78	7,37865	62,00	84,00		,034 *

As can be seen in Table 1, it was seen that the change in body weight of interval training and continuous running groups before and after the training process was statistically significant also ($p<0.05$).

Table 2: Cooper test

Cooper (meter)	N	X	Sd	Min	Max	Z	Asymp.sig (2-tailed
Int.Grup-1	9	2498,8889	204,35535	2250,00	2800,00	-2,670[a]	
Int.Group-2	9	2754,4444	269,81990	2350,00	3200,00		,008*
Cont.R.Group-1	9	2440,5556	215,81885	2180,00	2730,00	-2,673[a]	
Cont.R.Group-2	9	2501,1111	232,13382	2200,00	2810,00		,009*

As can be seen from Table 2, the change in the Cooper test values of the interval training and continuous running groups before and after the training process was also found to be statistically significant ($p<0.05$).

Table 3: Standing long jump test

Long jump (cm)	N	X	Sd	Min	Max	Z	Asymp.sig (2-tailed
Int.Grup-1	9	202,8889	18,18959	175,00	231,00	-2,552[a]	
Int.Group-2	9	227,6667	31,83944	192,00	285,00		,011*
Cont.R.Group-1	9	214,4444	9,68389	201,00	230,00	-1,265[a]	
Cont.R.Group-2	9	214,8889	9,45310	202,00	229,00		,206

When Table 3 was examined, it was observed that the change in the standing long jump values of the interval training group before and after the training process was statistically significant ($p<0.05$), while the change in the continuous running group was not statistically significant.

Table 4: Vertical jump test variations of interval and continuous running groups

Vertical jump	N	X	Sd	Min	Max	Z	Asymp.sig (2-tailed
Int.Grup-1	9	48,44	4,75	39,00	55,00		
Int.Group-2	9	54,55	8,23	37,00	67,00	-2,492	,013*
Cont.R.Group-1	9	47,7778	5,69600	40,00	56,00	-,632[a]	,527
Cont.R.Group-2	9	48,0000	6,12372	39,00	57,00		

A Based on positive ranks. * Significant difference between measurements

B Wilcoxon Signed Ranks Test

When Table 4 was examined, it was observed that the change in the vertical jump values of the interval training group before and after the training process was statistically significant (p<0.05), while the change in the continuous running group was not statistically significant.

Table 5: Sit-and-reach test

Sit-and-reach	N	X	Sd	Min	Max	Z	Asymp.sig (2-tailed
Int.Grup-1	9	37,0000	3,93700	30,00	41,00	-2,694[a]	
Int.Group-2	9	39,1111	3,82245	34,00	45,00		,007*
Cont.R.Group-1	9	32,5556	3,60940	28,00	39,00	-1,897[a]	
Cont.R.Group-2	9	33,2222	3,49205	29,00	39,00		,058

A Based on positive ranks. * Significant difference between measurements
B Wilcoxon Signed Ranks Test

As it can be seen in the Table 5, it was observed that the change in the sit-and-reach test values of the interval training group before and after the training process was statistically significant (p<0.05), while the change in the continuous running group was not statistically significant.

Table 6: 20 m speed test

20-meters speed	N	X	Sd	Min	Max	Z	Asymp.sig (2-tailed
Int.Grup-1	9	2,9267	,11874	2,71	3,11	2,670[a]	,008*
Int.Group-2	9	2,8800	,10050	2,70	3,00		
Cont.R.Group-1	9	2,9367	,10000	2,70	3,05	-1,619[a]	,105
Cont.R.Group-2	9	2,9278	,08243	2,75	3,04		

A Based on positive ranks. * Significant difference between measurements
B Wilcoxon Signed Ranks Test

As it can be seen in the Table 6, it was observed that the change in the speed test values of the interval training group before and after the training process was statistically significant (p<0.05), while the change in the continuous running group was not statistically significant.

Table 7: Balance test

Balance	N	X	Sd	Min	Max	Z	Asymp.sig (2-tailed
Int.Grup-1	9	12,00	4,39	5,00	19,00		
Int.Group-2	9	8,11	2,03	5,00	11,00	-2,371	,018*
Cont.R.Group-1	9	13,88	6,73	1,00	20,00		
Cont.R.Group-2	9	14,00	5,79	2,00	20,00	-,071	,944

A Based on positive ranks. * Significant difference between measurements
B Wilcoxon Signed Ranks Test

As it can be understood from the Table 7, it was observed that the change in the balance test values of the interval training group before and after the training process was statistically significant (p<0.05), while the change in the continuous running group was not statistically significant. First and second measurement levels of the test groups were found to be statistically significant (P0,05). In the control group, no significant difference was observed between the first and second measurement values.

DISCUSSION

While continuous running training show its greatest impact on the body's oxygen transport system, interval endurance training has the greatest impact on the structural and biochemical properties of the muscle. The physiological basis of both training methods is discussed, and regular training throughout the year is important to increase the anaerobic threshold. An individual's maxVO2 has been noted to constitute one of the most important determinants of aerobic endurance performance or capacity, and numerous studies have investigated overall differences in VO2peak among individuals of different ages [30,31]. In some studies, maxVO2 alone is a poor predictor of endurance performance [11] and factors related to maximum power production by the muscles rather than the cardiovascular system have been suggested to limit performance [25]. Cao et al (2019) noted that interval training methods had greater improvements in cardiovascular fitness among children and adolescents compared to continuous running Endurance training. Although there are studies examining the effects of interval and continuous running training on the physiological characteristics of athletes [32,33,14], many studies mention different impacts of continuous running and interval training methods [34,35,36]. This study aims to compare the physical and physiological effects of continuous and interval running training in elite adults.

In many studies, it has been stated that the training programs applied to improve endurance cause changes in the physical characteristics of the athletes, while most of them do not cause change in the physical properties. Studies investigating the effects of endurance training on body weight and body composition have been found to be effective in reducing body weight [37,38,39]. In the results of our study, it was determined that there was a significant difference in body weight in the pre-test and post-test results of the interval and continuous running endurance

training program. However, some studies have reported that the effects of endurance training on body weight and body fat ratio variables are not significant [40,41,42,43]. In other similar studies, it has been reported that continuous running has a more significant effect on reducing body weight compared to interval training [24,44].

Revan et al 2008, who investigated the effects of 8-week continuous and interval training on aerobic capacity, reported that both training methods had similar effects [24]. Sever and Cicioğlu 2018 reported that interval training has positive effects on aerobic parameters in swimmers [43]. Demiriz et al. stated that interval training had a positive effect on anaerobic capacity. Koç 2010 reported that endurance training has positive effects on aerobic capacity in male handball players. In studies conducted on endurance runs, it has been determined that continuous and interval trainings of different intensity and scope have positive effects on aerobic capacity [45,20,46,47]. When interval trainings are compared with other endurance trainings, it has been stated that interval running trainings has insignificant impact on VO2max [48,14,49]. Karayiğit et al. 2020 stated that the interval training method is important for the development of aerobic capacity [49]. Eddy et al. 1977 examined the impacts of continuous runs and internal trainings on aerobic capacity of women and men and found that both endurance trainings have the same physiological impacts [50]. In the results of the training program we applied in our study, it was determined that the positive effects of continuous and interval running on aerobic capacity were similar to the studies conducted.

When the studies conducted for the development of motor performance were examined, they concluded that motor performance was generally related to muscle strength and physical power, and that resistance training was effective on motor performance [51]. Weston et al. 2014 stated that low volume interval running trainings ensure medium-level improvements on aerobic strength of active individuals who are not athletic and sedentary individuals, and more studies are needed to determine the unclear variable impacts of sex and interval running trainings on aerobic strength and unclear effects on sprint performance and other motor properties [52]. On the other hand, Martland et al 2019 in their research conducted on the effects of interval sunning trainings on performance reported that the effects on cardiovascular system are predominant, however it is a suitable method for physical fitness and motor performance development [39]. Aschendorf et al. 2018 examined the effects of interval running trainings on physical and physiological properties of basketball players and stated that interval running trainings positively improved aerobic capacity and sprint performance while it has no effect on other motor characteristics such as vertical and horizontal jump [53]. However, it has been found that studies which research the effects of interval and continuous running training methods especially on physiological and motor characteristics together are limited [54,38]. Bostancı et al. 2019 reported that results of their study which compared the percentage changes in interval and continuous endurance training groups obtained statistically significant improvement in favor of interval group in all parameters except flexibility, and as a result, 6-week interval running training in elite athletes had more positive effects on respiratory muscle strength and other standing long jump performance compared to continuous running training program [38]. Considering that interval running trainings provide positive response to physiological adaptation level of athletes in a short time, they stated that it would make positive contributions to the competition between elite athletes. When the effects of continuous and interval running trainings are compared in terms of their effects on motor performance, Gibala et al. 2006 stated that low volume HIT is a productive strategy in terms of time comparable with improvements after continuous (traditional) endurance training for fast physiological and performance improvements [55]. In their study for researching football-specific sided games and interval running trainings on physical performance, psychophysiological responses and technical skills of young football players, Arslan et al. 2020 stated that small sided games are more effective in terms of improving agility and technical properties compared to interval running trainings, however, interval running training has more effects in terms of 1000-meters running protocol and spring values [56,60,61]. In addition, it has been determined that both loading protocols have the same positive effects on the development of the respiratory (aerobic capacity) system and are similar to other studies in the field [57,58,62,63]. Bradley et al. 2020 researched the effect of interval running trainings on motor performance and reported that motor performance positively improved after applied interval runs [59]. Meßler et al. 2016 stated that controlled intensity interval running trainings increased oxygen use capacity in addition to motor skill development and especially positively affected dynamic balance properties [31]. It is seen that the effects of the interval training program applied in our study have similar effects with the literature.

CONCLUSION

As a result, it is seen that both continuous running and interval running trainings provide significant changes on the physical and physiological characteristics of elite adults. In addition, when the two training methods were compared, it was concluded that the results obtained in motor performance after interval training were higher than those of continuous running. In studies where the effects of both training methods will be observed in different ages and groups, it may be recommended to conduct more research on duration, frequency and intensity.

Conflicts of interest: The authors declare that there is no conflict of interest about this manuscript.

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