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The Effect of Different Rest Periods on Blood Lactate Levels During Circuit Training

Emre YAMANER[1*]
Abdullah DEMİRLİ[2]
Cemre Can AKKAYA[3]
Mustafa Ertuğrul ÇIPLAK[4]
Laurențiu Gabriel TALAGHIR[5*]
Daniel Andrei IORDAN[6]
Sebastian Ion ENACHE[7]

[1] Hitit University, Sungurlu Vocational School of Higher Education, Çorum, Turkey, emreyamaner@hitit.edu.tr
[2] İstanbul Yeni Yüzyıl University, Faculty of Sport Sciences, İstanbul, Turkey, abdullah.demirli@yeniyuzyil.edu.tr
[3] İstanbul Yeni Yüzyıl University, Faculty of Sport Sciences, İstanbul, Turkey, cemrecan.akkaya@yeniyuzyil.edu.tr
[4] Bülent Ecevit Unıversıty, School Of Physıcal Educatıon And Sport, Zonguldak, Turkey, mertuğrul.ciplak@beun.edu.tr
[5] Dunărea de Jos University of Galaţi, Romania, gtalaghir@ugal.ro
[6] Dunărea de Jos University of Galaţi, Romania, daniel.iordan@ugal.ro
[7] Centrul Universitar Piteşti, Piteşti – România, enachecst@yahoo.com
***Corresponding authors**: emreyamaner@hitit.edu.tr, gtalaghir@ugal.ro

Abstract: ***Aim:*** *Circular training is thought to have a motivating feature by distracting the individual from routine and boring training practices with different exercise methods. In this context, the aim of this study was to investigate the effect of different rest periods applied during circular training on blood lactate levels.* ***Method:*** *The pretest-posttest model was used in the study. The sample of the study consisted of 24 (X_{age} =20,00±1,79; X_{height} =171,75 ± 6,22; X_{weight} =75,01± 6,39) volunteer male basketball athletes. Lactate measurements were taken before, during and after circular training with different rest periods. The data was analyzed in the SPSS 24.0 package program, with a 95% confidence interval and a 0.05 significance level, and normality analysis was performed with the Shapiro-Wilk test. Since the data were not normally distributed, nonparametric tests were applied. The change in heart rate averages and lactate levels of the research group according to resting times were evaluated by Wilcoxon Test.* ***Results:*** *In general, it was determined that the circular training program with different rest intervals caused significant differences in the measurement parameters (Heart Rate, and Lactate) of the participants ($p<0.05$). It was observed that the average heart rate and lactate values reached during training decreased as the rest period of the research group increased. On the other hand, the effects of long-term circular training programs with different rest intervals on aerobic-anaerobic energy metabolism will contribute to the literature.*

Keywords: *circuit training, lactate, heart rate, recovery, basketball.*

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Introduction

Circular training has been a prominent approach in sports training in recent years. This training approach aims to optimize athletes' performance on the field by focusing on developing all-round physical skills. Circular training has a structure in which various exercises are cyclically sequenced between a series of stations or points and worked at each station for a certain period of time. This method is used to improve cardio endurance as well as basic physical abilities such as muscular strength, agility, balance and coordination (Impellizzeri et al., 2006). In general terms, circular training is a form of training that can be designed in various protocols (Jung & Park, 2018; Beckham & Earnest, 2000), consisting of two or more stations organized consecutively to achieve the desired goal, taking into account parameters such as muscle contraction, mass amount and recovery, and muscle fibril composition (Nasiri et al., 2011) of resistance or non-resistance strength training. The general aim of different training methods that serve many purposes is to improve the physiological capacity and physical abilities of individuals (Yamaner & Kartal, 2010). These different training methods can be aimed at increasing the technical-tactical capacity of athletes, or they can be organized and applied in line with the needs of sports branches in order to develop basic motoric characteristics such as strength or endurance (Victor, 2021). The Circular Training Method, developed by Morgan and Adamson in 1957, is a training method designed to develop multiple motor skills simultaneously (Zatsiorsky at al., 2006). When programming circular training, it is important to make sure that the exercise movements can work the muscles of the legs, core, arms, shoulders, trunk and back. At the moment of execution, the exercise that works each muscle group is followed by an exercise that works another muscle group (Carrera & Bompa, 2007). Successful training of muscle groups is possible by creating a successful program obtained by determining the volume and intensity of the training correctly (Scholich, 1992). When planning circular workouts, the aim is to get the best efficiency from the planned workout. However, the expected efficiency may vary. In fact, training methods may have different physical and physiological effects on individuals (Hazar, 2004). In high intensity exercise, muscle damage will be greater and fatigue will occur more quickly. Muscular fatigue is defined as the inability to produce a certain power through muscle contraction. Fatigue is a natural result of physical or mental activity (Günay et al., 2013). Fatigue occurs earlier with incomplete or no recovery. When designing workouts, recovery conditions should be well understood and used effectively. Thus, recovery times will become a

permanent part of training (Victor, 2021). Basically, there are two main factors that cause fatigue. These are oxygen deficiency (hypoxia) and accumulation of metabolites (lactic acid/lactate) (Noyan, 2011). Lactic acid, one of the metabolites accumulated in blood and muscle during physical activity, is excreted from the body during recovery (Fox et al., 1988).

Nowadays, training methods and strategies are continuously researched and developed to improve sports performance and athletes' efficiency. In this context, circular training, which plays an important role in improving physical conditioning, has been widely used to increase endurance and improve aerobic capacity in athletes. However, the effect of rest periods during circular training on blood lactate levels is still poorly understood. Inspired by this information, the aim of this study was to investigate the effect of different lengths of rest periods between stations on blood lactate levels and heart rate in circular training method applications. The results of this study can provide an important guideline for athletes to plan and optimize their training programs more effectively.

Method

Research Group

G-Power analysis was performed to determine the sample size of the research group. The participants consisted of 24 volunteer male basketball athletes (X_{age} =20,00± 1,79; X_{height} =171,75± 6,22; X_{weight} =75,01± 6,39; $X_{fat\ percentage}$=11,75±3,50). The inclusion criteria were having a sports history of at least one year, not having any health problems, doing active sports and having strength training experience. Individuals with any health problems and no sports history were excluded from the study. The study was conducted in accordance with the Declaration of Helsinki and with the approval of Ondukuz Mayıs University Clinical Research Ethics Committee.

Training Protocol

Before the 3 training day protocol, the participants performed warm-up movements for the exercise movements to be applied after the 1st lactate measurements were taken and warm-up movements were performed with 7 minutes of flat running. Before the study, the participants were informed not to use any medication or nutritional supplements during the training period. The circular training series consists of 8 movements, 4 sets with 20 sec (seconds) of loading for each movement, including Russian Kettlebell Swing, Full Squat, Benchpress, Mountain Climbers, Single-Arm Kettlebell Snatch, Deathlift, Military Press and Russian Twist. In the circular training series, the

rest time between sets was 2 minutes, and the rest time between movements was 20_{sec} on Day 1, 30_{sec} on Day 2, and 40_{sec} on Day 3.

Anthropometric Measurements

The height (cm) of the research group was measured with an accuracy of 1 mm using a SECA brand 213 model stadiometer with bare feet, feet flat on the ground, heels together, knees stretched and body in an upright position. "Tanita Body Composition Analyzer BC-418" bioelectrical impedance analyzer was used to determine the body fat percentages of the research group. In order to determine the body composition of the research group, the volunteers were asked to stand on the platform barefoot after their height, age, gender, and clothing weight were reduced and entered as data on the analyzer screen. Body mass index (BMI), body fat mass and body fat percentage were measured.

Blood Lactate Measurements

Blood lactate values of the research group were determined with the Lactate Plus Blood Lactate Measuring Meter, which uses 0.5 µl blood samples taken from capillary blood with the help of a lancet. The blood lactate measurement interval of the research group was performed in the same order for each 3 exercise days and this order is given in Table 1.

Table-1: Lactate Measurement Range Of The Research Group

Sequence Number	Time of Measurement
1. Lactate Measurement	Just before you start exercising
2. Lactate Measurement	At the end of the 1. set
3. Lactate Measurement	At the end of the 2. set
4. Lactate Measurement	At the end of the 3. set
5. Lactate Measurement	At the end of the 4. set
6. Lactate Measurement	15 minutes after the end of training
7. Lactate Measurement	30 minutes after the end of training
8. Lactate Measurement	45 minutes after the end of training
9. Lactate Measurement	60 minutes after the end of training

Heart Rate Measurements

The heart rate (HR) values of the research group were measured with a Polar V800 GPS heart rate monitor. During the circular training with 20_{sec}, 30_{sec} and 40_{sec} rest and until 1 hour after the end of the training, the average of the athlete's HR values (HR_{avg}) was determined and recorded.

Data Analysis

The analysis of the data in this study was evaluated in SPSS 24.0 package program at 95% confidence interval and 0.05 significance level. Normality analysis of the data was tested by Shapiro-Wilk test. Since the data did not show normal distribution, nonparametric statistical tests were applied. The change in heart rate averages and lactate levels of the research group according to resting times were evaluated by Wilcoxon Test.

Table 2. Mean and Standard Deviation Values of Mean Heart Rate Values of the Training Program Applied with 20_{sec}, 30_{sec} and 40_{sec} Rest Periods of the Research Group

	n	Minimum	Maximum	Mean	Std. Deviation
HR_{avg} 20_{sec}	24	139,00	157,00	149,28	4,23
HR_{avg} 30_{sec}	24	134,00	155,00	144,79	4,90
HR_{avg} 40_{sec}	24	127,00	152,00	139,75	5,98

**sec:seconds, *avg:average*

Table 3. Wilcoxon Test Results of the Difference Between the Mean Values of the Heart Rate of the Training Program Applied with 20, 30 and 40 Second Rest Periods of the Research Group

	n	Z	p
HR_{avg} 20_{sec} – HR_{avg} 30_{sec}	24	-4,296	,000
HR_{avg} 20_{sec} – HR_{avg} 40_{sec}	24	-4,298	,000
HR_{avg} 30_{sec} – HR_{avg} 40_{sec}	24	-4,295	,000

*sec:seconds, *avg:average

When Table 3 is examined, HR_{avg} is statistically significant between all groups ($p<0.05$).

Table 4. Mean and Standard Deviation Values of Lactate Measurements Taken with 20_{sec}, 30_{sec} and 40_{sec} Listening Times of the Research Group

	n	Minimum	Maximum	Mean	Std. Deviation
Lactate 20_{sec} 1.$_{meas}$	24	2,50	3,50	3,0208	,30069
Lactate 20_{sec} 2.$_{meas}$	24	9,50	15,60	12,6000	1,78301
Lactate 20_{sec} 3.$_{meas}$	24	11,30	16,90	14,3125	1,49443
Lactate 20_{sec} 4.$_{meas}$	24	13,10	18,10	16,0583	1,35387
Lactate 20_{sec} 5.$_{meas}$	24	14,60	19,40	17,8292	1,08927
Lactate 30_{sec} 1.$_{meas}$	24	2,50	3,70	3,1000	,27346
Lactate 30_{sec} 2.$_{meas}$	24	8,50	14,70	11,5750	1,78307
Lactate 30_{sec} 3.$_{meas}$	24	10,20	17,70	13,3583	1,91446
Lactate 30_{sec} 4.$_{meas}$	24	12,50	17,10	14,6833	1,19443
Lactate 30_{sec} 5.$_{meas}$	24	13,10	17,90	16,3417	1,01977
Lactate 40_{sec} 1.$_{meas}$	24	2,50	3,50	3,0000	,23406
Lactate 40_{sec} 2.$_{meas}$	24	7,00	13,50	10,1083	1,58002
Lactate 40_{sec} 3.$_{meas}$	24	9,20	14,60	11,9750	1,58560
Lactate 40_{sec} 4.$_{meas}$	24	10,60	16,60	13,7167	1,47844
Lactate 40_{sec} 5.$_{meas}$	24	11,20	17,10	14,7292	1,21243
Lactate 20_{sec} 6.$_{meas}$	24	10,00	15,20	13,0000	1,13979
Lactate 20_{sec} 7.$_{meas}$	24	4,20	10,50	8,8167	1,59882
Lactate 20_{sec} 8.$_{meas}$	24	2,80	6,90	5,8875	1,04479
Lactate 20_{sec} 9.$_{meas}$	24	1,80	4,50	3,4208	,56797
Lactate 30_{sec} 6.$_{meas}$	24	8,20	13,50	11,3500	1,25733
Lactate 30_{sec} 7.$_{meas}$	24	3,50	9,70	7,5292	1,61958
Lactate 30_{sec} 8.$_{meas}$	24	2,20	6,40	4,9292	1,04444
Lactate 30_{sec} 9.$_{meas}$	24	1,50	4,20	3,0708	,58643
Lactate 40_{sec} 6.$_{meas}$	24	6,10	11,20	9,4292	1,21708
Lactate 40_{sec} 7.$_{meas}$	24	2,70	8,60	6,4250	1,73562
Lactate 40_{sec} 8.$_{meas}$	24	1,80	5,30	3,8958	,99367
Lactate 40_{sec} 9.$_{meas}$	24	1,10	3,50	2,5417	,61000

*sec:seconds, *meas:measurement

Table 5. Wilcoxon Test Results of the Differences Between the Sets of Lactate Measurement Values of the Research Group Taken with 20_{sec}, 30_{sec} and 40_{sec} Listening Times

	n	Z	p
Lactate 20_{sec} 1.$_{meas}$ – Lactate 30_{sec} 1.$_{meas}$	24	1,642	,100
Lactate 20_{sec} 1.$_{meas}$ – Lactate 40_{sec} 1.$_{meas}$	24	-,393	,694
Lactate 30_{sec} 1.$_{meas}$ – Lactate 40_{sec} 1.$_{meas}$	24	1,770	,077
Lactate 20_{sec} 2.$_{meas}$ – Lactate 30_{sec} 2.$_{meas}$	24	4,173	,000
Lactate 20_{sec} 2.$_{meas}$ – Lactate 40_{sec} 2.$_{meas}$	24	4,289	,000
Lactate 30_{sec} 2.$_{meas}$ – Lactate 40_{sec} 2.$_{meas}$	24	4,291	,000
Lactate 20_{sec} 3.$_{meas}$ – Lactate 30_{sec} 3.$_{meas}$	24	4,014	,000
Lactate 20_{sec} 3.$_{meas}$ – Lactate 40_{sec} 3.$_{meas}$	24	4,294	,000
Lactate 30_{sec} 3.$_{meas}$ – Lactate 40_{sec} 3.$_{meas}$	24	4,303	,000
Lactate 20_{sec} 4.$_{meas}$ – Lactate 30_{sec} 4.$_{meas}$	24	4,291	,000
Lactate 20_{sec} 4.$_{meas}$ – Lactate 40_{sec} 4.$_{meas}$	24	4,290	,000
Lactate 30_{sec} 4.$_{meas}$ – Lactate 40_{sec} 4.$_{meas}$	24	4,288	,000
Lactate 20_{sec} 5.$_{meas}$ – Lactate 30_{sec} 5.$_{meas}$	24	4,293	,000
Lactate 20_{sec} 5.$_{meas}$ – Lactate 40_{sec} 5.$_{meas}$	24	4,288	,000
Lactate 30_{sec} 5.$_{meas}$ – Lactate 40_{sec} 5.$_{meas}$	24	4,291	,000

*sec:seconds, *meas:measurement

When Table 5 is analyzed, there is no statistically significant difference between Lactate 20_{sec} 1, Lactate 30_{sec} /1 and Lactate 40_{sec} /1 ($p>0,05$). All other lactate measurements of training days with different rest periods, between sets and until the end of training were statistically significant ($p<0.05$).

Table 6. Wilcoxon Test Results Regarding the Differences of the Lactate Measurement Values of the Research Group Taken with 20_{sec}, 30_{sec} and 40_{sec} Listening Times at Different Minutes After Training

	n	Z	p
Lactate 20_{sec} $6._{meas}$ – Lactate 30_{sec} $6._{meas}$	24	-4,293	,000
Lactate 20_{sec} $6._{meas}$ – Lactate 40_{sec} $6._{meas}$	24	-4,289	,000
Lactate 30_{sec} $6._{meas}$ – Lactate 40_{sec} $6._{meas}$	24	-4,291	,000
Lactate 20_{sec} $7._{meas}$ – Lactate 30_{sec} $7._{meas}$	24	-4,293	,000
Lactate 20_{sec} $7._{meas}$ – Lactate 40_{sec} $7._{meas}$	24	-4,287	,000
Lactate 30_{sec} $7._{meas}$ – Lactate 40_{sec} $7._{meas}$	24	-3,631	,000
Lactate 20_{sec} $8._{meas}$ – Lactate 30_{sec} $8._{meas}$	24	-4,202	,000
Lactate 20_{sec} $8._{meas}$ – Lactate 40_{sec} $8._{meas}$	24	-4,293	,000
Lactate 30_{sec} $8._{meas}$ – Lactate 40_{sec} $8._{meas}$	24	-4,300	,000
Lactate 20_{sec} $9._{meas}$ – Lactate 30_{sec} $9._{meas}$	24	-4,338	,000
Lactate 20_{sec} $9._{meas}$ – Lactate 40_{sec} $9._{meas}$	24	-4,301	,000
Lactate 30_{sec} $9._{meas}$ – Lactate 40_{sec} $9._{meas}$	24	-4,305	,000

*sec:seconds, *meas:measurement

When Table 6 is analyzed, all lactate measurements taken after the end of training were statistically significant ($p<0.05$) when different resting times were considered.

Discussion and Conclusion

When the literature was examined, there were no studies on different rest periods of circular training. It was observed that as the resting time of the research group increased, the maximum heart rate reached during training decreased. In the lactate measurements taken before the training program, there was no significant difference between lactate $20_{sec}1._{meas}$, lactate 30_{sec} $1._{meas}$ and lactate 40_{sec} $1._{meas}$; in all other lactate test results, the lactate test values of the training with 20_{sec} rest time were higher than the lactate test values of the training with 30_{sec} rest time and the lactate test values of the training with 40_{sec} rest time. The lactate test values of the training with 30_{sec} resting time were higher than the lactate test values of the training with 40_{sec} resting time. According to this result, lactate production of

metabolism increases as the resting time shortens in circular training applications.

Impellizzeri et al. (2019), in a study evaluating the effects of circular training on cardiovascular responses, observed that circular training increased heart rate and improved cardiovascular endurance. In addition, Shemelis Belachew (2020), reported in their study that circular training can increase aerobic capacity by detecting improvements in heart rate. In the research we conducted, it was observed that the average heart rate decreased as the resting time prolonged in the circular training period performed with different rest intervals. On the other hand, when we look at the studies examining the metabolic responses of circular training in the literature; it was observed that circular training increased lactate levels and improved anaerobic capacity (Sandford et al., 2021; Zinner et al., 2014). In another study with similar results, Hazell et al. (2012) reported that circular training increased lactate levels and improved anaerobic performance. Paoli et al., (2010) reported that high-intensity circular training combined with endurance training improved blood lactate threshold compared to endurance training alone or low-intensity circular training combined with endurance training. As a result, it was found that lactate level and HR values increased as resting time decreased in circular training applications. In addition, it was seen that the application of circular training movement application and rest periods recommended for the development of endurance and strength continuity were insufficient with 1/1 rest-load, 1.5/1 rest-load time showed better results than 1/1 rest-load time in applying the initial movement time towards the last sets, but it was still insufficient, and in 2/1 rest-load time, the closest values to the initial performance of the exercises were reached. Moreover, the effect of circular training on lactate levels of basketball players may vary depending on factors such as training protocol, physiological characteristics and adaptations of athletes. More comprehensive and up-to-date research is needed to better understand the effects of this type of training on lactate levels. The information obtained from this study needs to be reinforced by further studies by other researchers. In addition, studies investigating the effects of long-term circular training programs with different rest intervals on aerobic-anaerobic energy metabolism will contribute to the literature.

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All authors contributed equally to the article.

References

Beckham, S. G., & Earnest, C. P. (2000). Metabolic cost of free weight circuit weight training. *Journal of sports medicine and physical fitness*, *40*(2), 118.

Carrera, M., & Bompa,T., (2007). Theory and methodology of training: General perspectives. *Psychology of sport training*, 19-39.

Fox, E. L., Bowers, R.W. & Foss, M.L. (1988). The physiological basis of physical education and athletics, 4th edition. Saunders College Pub

Günay, M., Tamer, K., Cicioğlu, H. İ., (2013). Spor fizyolojisi ve performans olcümü.[Sports physiology and performance measurement tests] Gazi Bookstore

Sandford, G. N., Laursen, P. B., & Buchheit, M. (2021). Anaerobic Speed/Power Reserve and Sport Performance: Scientific Basis, Current Applications and Future Directions. *Sports medicine (Auckland, N.Z.)*, *51*(10), 2017–2028. https://doi.org/10.1007/s40279-021-01523-9

Hazar, S. (2004). Egzersize bağlı iskelet ve kalp kası hasarı. *Spormetre Beden Eğitimi ve Spor Bilimleri Dergisi*, *2*(3), 119-126. https://doi.org/10.1501/Sporm_0000000141

Hazell, T. J., Olver, T. D., Hamilton, C. D., & Lemon P, W. R. (2012). Two minutes of sprint-interval exercise elicits 24-hr oxygen consumption similar to that of 30 min of continuous endurance exercise. *International journal of sport nutrition and exercise metabolism*, *22*(4), 276–283. https://doi.org/10.1123/ijsnem.22.4.276

Impellizzeri, F. M., Marcora, S. M., Castagna, C., Reilly, T., Sassi, A., Iaia, F. M., & Rampinini, E. (2006). Physiological and performance effects of generic versus specific aerobic training in soccer players. *International journal of sports medicine*, *27*(6), 483–492. https://doi.org/10.1055/s-2005-865839

Impellizzeri, F. M., Marcora, S. M., & Coutts, A. J. (2019). Internal and external training load: 15 years on. Int J Sports Physiol Perform, 14(2), 270-273. https://doi.org/10.1123/ijspp.2018-0935

Jung, W. S., & Park, H. Y. (2018). Circuit exercise promotes health related factors in sarcopenic obesity elderly: a mini-review. MOJ Gerontology & Geriatrics, 3(3), 233-236. DOI: 10.15406/mojgg.2018.03.00122

Nasiri, R., Damırchı, A., & Mirzaei, B. (2011). The effect of duration and type of rest interval between sets with low and moderate intensities on the volume of bench press in untrained men. *Researcher in Sport Science Quarterly*, *2* (2): 25- 33. https://journals.iau.ir/article_511315_9005e7a5cb8006cc4f3fa390a70c2170.pdf

Noyan, A. (2011). *Yaşamda ve hekimlikte fizyoloji* [*Physıology ın lıfe and medıcıne*]. Meteksan

Paoli, A., Pacelli, F., Bargossi, A. M., Marcolin, G., Guzzinati, S., Neri, M., Bianco, A., & Palma, A. (2010). Effects of three distinct protocols of fitness training on body composition, strength and blood lactate. *The Journal of sports medicine and physical fitness*, *50*(1), 43–51.

Scholich, M. (1992). *Circuit training for all sports: methodology of effective fitness training*. Sport Books Publishers.

Shemelis Belachew, Y. (2020). Effects of aerobıc-cırcuıt exercıse on muscular and cardıovascular endurances of male students: The case of Haramaya Unıversıty model hıgh school; *Oromıa Regıonal State, Ethopıa (Doctoral dissertation, Haramaya university)*.

Yamaner, F., & Kartal, A. (2010). Beden egitimi ve spor bölümlerinde okuyan erkek hentbol ı. liginde oynayan hücum ve savunma oyuncularının seçilmiş fiziksel ve fizyolojik profilleri [Physical and physiological profile of first division of offensive and defensive male physical educatıon] *H. Beden Eğitimi ve Spor Bilimleri Dergisi*, *1*(4).

Zatsiorsky, V. M., Kraemer, W. J., & Fry, A. C. (2006). Science and practice of strength training. (2nd ed.). *Human Kinetics*.

Zinner, C., Wahl, P., Achtzehn, S., Reed, J. L., & Mester, J. (2014). Acute hormonal responses before and after 2 weeks of HIT in well trained junior triathletes. *International journal of sports medicine*, *35*(4), 316–322. https://doi.org/10.1055/s-0033-1353141