EFFECT OF PLIOMETRIC TRAINING ON ANAEROBIC PERFORMANCE IN YOUNG BASKETBALL PLAYERS

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ABSTRACT

The purpose of this study was to determine the effects of plyometric training in two different training frequencies between the competition seasons on vertical jump performance, anaerobic capability. Male basketball players aged 15-17 participated in this study. A total of 18 basketball players were divided into three groups as unbiased and in equal number (n=6); two experimental and one control group. One of these groups applied the drop jump plyometric exercise following the basketball training routine once a week while the other two groups did it three times a week, and, then, the training was completed with a stretching exercise. The study of the control group was completed with a stretching exercise after the routine. The training took eight weeks. Some measurements were taken before and after the eight weeks of the training session. Anaerobic power and capacity was recorded by the Wingate anaerobic test. Statistical comparisons among the three groups in this study were calculated by taking mean values of dependent variables, and Mann-Whitney U test, and Wilcoxon signed rank test was used for significance effects of dependent variables. Significance level was determined as $p < 0.05$. At the end of the training, it was observed that the values of the anaerobic power and capacity values of plyometric exercise groups showed statistically significant improvements. A statistically significant increase in the values of anaerobic power and capacity was provided for the experimental group doing the plyometric exercise once a week compared with the control group.
Key words: Plyometric Training, Anaerobic Performance, Basketball

GENÇ BASKETBOLCULARDA PLİYOMETRİK ANTRENMANIN ANAEROBİK PERFORMANS DEĞERLERİNE ETKİSİ

ÖZET

Bu araştırmanın amacı, yarışma sezonu içerisinde iki farklı antrenman sıklığında yapılan pliyometrik egzersizinin, anaerobik performans üzerindeki etkilerini incelemektir. Bu nedenle bir spor kulübünün yaşları 15 ile 17 arasında değişen genç erkek basketbol takımı oyuncuları çalışmaya alınmıştır. Toplam 18 sporcu tarafsız ve eşit sayıda (n=6) iki deney ve bir kontrol grubu olmak üzere üç gruba ayrılmıştır.

Deney gruplarından biri haftada bir gün diğeri ise haftada üç gün süreyle rutin basketbol antrenmanını takiben drop jump pliyometrik egzersizini uygulamış ve ardından gerdirme egzersizi yaparak çalışmayı tamamlamıştır. Kontrol grubu ise rutin basketbol antrenmanı sonrası gerdirme egzersizini yaparak çalışmayı sonlandırmıştır. Çalışma sekiz hafta boyunca devam etmiştir.

Sekiz haftalık egzersiz öncesinde ve sonrasında ölçümler yapılmıştır. Anaerobik güç ve kapasite Wingate anaerobik test ile kaydedilmiştir. Çalışmada üç grup arasındaki istatistiksel karşılaştırmalar, KruskalWallis test yöntemine göre bağımlı değişkenlerin ortalama değerleri alınarak hesaplanmış ve bağımlı değişkenlerin anlamlı etkileri için Mann-Whitney U testi ile Wilcoxon Eşleştirilmiş İki Örnek testi yapılmıştır. Anlamlılık düzeyi p<0,05 olarak tespit edilmiştir.

Çalışmalar sonunda pliyometrik egzersiz gruplarının anaerobik güç ve kapasite çalışma öncesine göre istatistiksel olarak anlamlı gelişme göstermiştir (p<0,05). Haftada üç gün pliyometrik egzersiz yapan grup kontrol grubu ve haftada bir gün pliyometrik egzersiz yapan gruba göre anaerobik güç ve kapasite değerlerinde istatistiksel olarak anlamlı artış sağlamıştır (p<0,05).
Anahtar Kelimeler: Pliyometrik Antrenman, Anaerobik Performans, Basketbol

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INTRODUCTION

Mankind has developed many training types from the past to the date to run faster, to bound higher and to throw any object farther (1). One should improve quick power in order to fulfill those desires. Quick power is the ability to apply force on an object or the body in order to give it high momentum. One of the most significant methods to improve quick power is the training that cover plyometric exercises (2,3). The exercises that targets at combining power and the speed of movement in order to create a movement are called plyometric exercises (2,4). Plyometric exercises cover all exercises used for creating eruptive reaction through tension reflex (5,6). In the skeleton muscle firstly eccentric contraction, and then concentric contraction occurs (4). This event occurs with the tension of the skeleton muscle eccentric contraction firstly and then evacuation of the skeleton muscle concentric contraction. Thus the skeleton muscle performs more powerful and faster contraction (1).

In our date plyometric exercises are included in basketball training programs (7, 8, 9) and undoubtedly it is one of the training methods that affects success in basketball and that is indispensable in developing physical performance (10). However the place of plyometric training within the basketball training has been an issue of debate. While it takes place significantly in annual training programs in pre-season period, it takes place so little within the season (8). Anaerobic performance is significant for success in basketball and it was suggested in the studies performed that plyometric training develops this aspect very well. (2, 4, 6, 11, 12, 13, 14). Considering those benefits, the place and frequency of plyometric training needed in competition season within basketball training is very significant and unfortunately there are very few studies in the literature performed about this subject.

The purpose of this study is to research the drop jump plyometric exercise performed by young male basketball players in competition season one and three days a week for eight weeks on anaerobic performance.

METHOD

Subject

The universe of this study is composed of 20 sportsmen in young male basketball team of a sports club. During the research, due to the failure of two sportsmen to continue exercise for various reasons, the total number of subjects decreased to 18 individuals. 18 male sportsmen participating in the research were divided into three groups objectively and randomly. The 1st group was determined as the control group (n= 6), the 2nd group was determined as the plyometric training group one day a week (n= 6), the 3rd group was determined as the plyometric training group three days a week (n= 6).

In this study the data of preliminary and final tests belonging to the subjects were collected in two different sessions one before starting 8 week training period and the other during the day following the end of the training period.

Sportsmen were provided,

- To have meal no later than 3 hours before the tests,
- Not to using any stimulants before the tests including medicine, tea and coffee and cigarette,
- To avoid from coercive physical activities before the tests,
- To participate in the tests wearing competition shorts and uniforms.

The data collection tools and test protocols used in this research are explained as follows in detail.

Measurement of Height, Weight and Body Fat Rate

In the research the heights of the sportsmen were measured using a metal meter assembled in the wall and their weights and body fat rates were measured using a Tanita make BF 556 model bioelectric impedance tool. Measurement of body fat using Tanita make tool is performed by measuring impedance

giving the body low frequency (50 kHz) electric currency. The electrolytes in the liquid of the body are good electrical conductive. The density in the liquid of the body being high causes the electric currency pass by encountering less resistance. Since fat cells fail to conduct electric currency immediately fat tissue has higher resistance. The device determines the body fat rate of the individual according to density difference (15).

Heights of the participants were measured as the body height from the heel to the top point of the head. During the measurement sportsmen were paid attention to be kept with naked feet, their feet closed, and the back of their heads, their backs and heels are kept adjacent to the measurement tool and making the measurement while reaching height after taking a deep breath. And in the weight and body fat rate measurements the measurement was performed when the sportsmen wore only their team uniforms composed of shorts and T-shirts.

Wingate Anaerobic Performance Test

Wingate anaerobic power and capacity test was performed in Monark 839E bicycle ergometer. The sportsmen got warm by turning pedal without load for 5 minutes and at the end of warming they performed a sprint trial of 5 seconds. The sportsmen were asked to turn pedal at the highest speed they could when they are ready and when they increased the speed up to 130 rpm within 4 seconds the load calculated over 75 g per kilogram of body weight was applied on the bicycle by the computer. The subjects tried to turn pedal at high speed against the resistance created by this load for 30 seconds. The subjects were encouraged verbally to keep the pedal speed high. The information belonging to the power parameters during the test was transferred to the software program in the computer through data connection. All power parameters were calculated by the computer software program. The highest peak power in 30 seconds was determined in (pp), and the average power in 30 seconds was determined as the average power (mp).

Application of Plyometric Training

Plyometric training groups applied the bound exercise known as *drop jump*. In this exercise the sportsmen jumps down over the desk and jumps up as fast and high as he/she can do at the moment when he/she comes down. While the sportsman falls from the desk and jumps his/her hands are fixed on his/her waist. The exercise was performed in 4 sets in the form of 10 repetitions. Breaks of 2 minutes were given between the sets. The height of the desk was determined as 50 centimeters. 1 day a week the plyometric training group performed weekly total 40 *drop jumps*, 3 days a week the plyometric training group performed weekly total 120 *drop jumps*.

In the research descriptive statistic was used for the analysis of data, in the differences between preliminary test and final test values of the groups Wilcoxon Matched Two Sampes Test was performed and in the comparisons between the groups since there was more than two groups Kruskal-Wallis Test was performed. And in order to determine between which groups there was difference Mann-Whitney U statistical test techniques were used.

In this study the meaningfulness level was determined as $p< 0.05$ at the beginning of the study and the analyses were performed in SPSS 11 for Windows 11 package program.

FINDINGS

With regard to the subjects participating in the study; the age average of the control group (1st group) is 16,16 ±0,98 years, the height average is 187,33 ±4,5 cm, the body weight average is 79,83 ±12,81 kg. The age average of the group performing plyometric training 1 day a week (2nd group) is 15,66 ±0,81 years, the height average is 184,83 ±14,03 cm, the body weight average is 72,01 ±15,84 kg. The age average of the group performing plyometric training 3 days a week (3rd group) is 16,16 ±0,98 years, the height average is 186,83 ± 12,60 cm, the body weight average is 69,90±11,39 kg. And the total age average of the 18 sportsmen participating in the exercise is 15,77 ± 0,87 years, the height average is 186,33 ±10,57 cm, the body weight average is 73,91 ±13,40 kg.

Their physical characteristics were indicated in Table 1 and no meaningful difference was detected between the values belonging to pre-training and post-training.

Table 1. Values of certain physical characteristics of the sportsmen

Groups	Height (cm)		Body Weight (kg)		BFR (%)	
	Pre traning mean±sd	Post training mean±sd	Pre traning mean±sd	Post training mean±sd	Pre traning mean±sd	Post training mean±sd
1st Group	187,33±4,50	187,83±4,40	79,83±12,81	80,53±11,91	14,98±6,44	14,75±5,93
2nd Group	184,83±14,03	185,66±13,55	72,01±15,84	72,81±15,29	13,18±4,63	13,56±4,58
3rd Group	186,83±12,60	187,66±12,06	69,90±11,39	70,73±11,41	10,93±6,62	11,21±5,91

The average values containing the results of the sportsmen in Wingate anaerobic power test after and before training were indicated in Table 2 and meaningful difference was detected in the values of 2nd group and 3. Groups' peak power (pp) and mean power (mp) after plyometric training. Furthermore when the differences between peak power and mean power values of the groups after and before training are compared in the 3rd group a meaningfully higher difference was detected compared to the 1st and 2nd group and in the 2nd group a meaningfully higher difference was detected compared to the 1st group.

Table 2. Peak power values of Wingate anaerobic power test

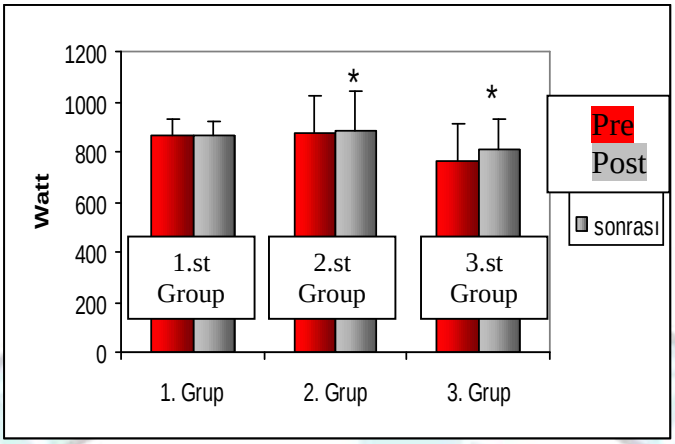
Groups	Peak Power (watt)		
	pre-training mean±sd	pre-training mean±sd	Difference mean±sd
1st Group	866±64,36	865,33±55,96	-0,66±11,43
2nd Group	871,50±149,61	884,66±152,67*	13,16±5,87
3rd Group	766,83±145,29	805±123,27*	38,16±12,44 [a,b]

* Significant difference compared to pre-training (p<0,05)
[a] Significant difference compared to the 1st group (p<0,0167)
[b] Significant difference compared to the 2nd group (p<0,0167)

Tablo 3. Comparison of peak power values between groups by benferroni

Comparison	p	Results
1st to 2nd	0.041	(p> 0.0167)
1st to 3rd	0.002	(p< 0.0167)
2nd to 3rd	0.004	(p< 0.0167)

Figure 1. Peak power values of Wingate anaerobic power test



* Significant difference compared to pre-training (p<0,05)

Table 4. Average power values of wingate anaerobic power test

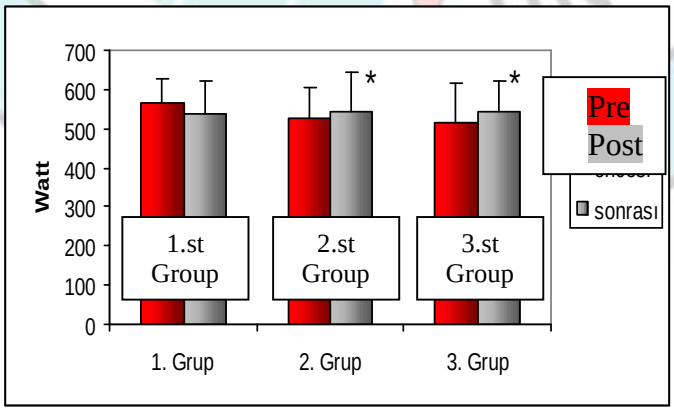
Groups	Mean Power(watt)		
	pre-training mean±sd	pre-training mean±sd	Difference mean±sd
1. 1st Group	568,90±59,18	565,27±60,55	-3,62±9,30
2. 2nd Group	524,94±77,15	537,77±82,38*	12,83±8,66
3. 3rd Group	515,33±101,87	540,44±104,13*	25,11±4,80 [a,b]

* Significant difference compared to pre-training (p<0,05)
[a] Significant difference compared to the 1st group (p<0,0167)
[b] Significant difference compared to the 2nd group (p<0,0167)

Tablo 5. Comparison of mean power values between groups by benferroni

Comparison	p	Results
1st to 2nd	0.026	(p> 0.0167)
1st to 3rd	0.002	(p< 0.0167)
2nd to 3rd	0.009	(p< 0.0167)

Figure 2. Average power values of Wingate anaerobic power test



* Significant difference compared to pre-training (p<0,05)

DISCUSSION

In this study, the peak power value determined with Wingate anaerobic test was determined in the control group in the pre-exercise measurement as 866±64,36 watt, and as 865,33±55,96 watt in the post-exercise measurement.While the average power value was 568,90±59,18 watt in the first measurement and 565,27±60,55 watt in the last measurement. The last measurements in the control group did not create meaningful difference compared to the first measurements ($p>0,05$) in statistical terms. While in the 2nd group which performed 1 day plyometric training for 8 weeks the peak power value was 871,50±149,61 watt it increased to 884,66±152,67 watt. And while the average power value was 524,94±77,15 watt it increased to 537,77±82,38 watt. And in the 3rd which performed 1 day plyometric training for 8 weeks the peak power value was 766,83±145,29 watt in the pre-exercise measurement, it increased to 805±123,27 watt in the post-exercise measurement, and while the average power was 515,33±101,87 watt it increased to 540,44±104,13 watt. Those increases that occurred in the 2nd and 3rd groups after plyometric training were found to be meaningful compared to pre-training in statistical terms ($p<0,05$). Furthermore, assessing the developmental differences of the groups the increase that occurred in the 3rd group was significant compared to the 1st and 2nd group ($p<0,0167$).

Luebbers et. Al. suggested that the anaerobic power in the groups performing plyometric training increased meaningfully in statistical terms compared to the control group in the research they conducted on physically active males in high school (1). Duda suggested that significant increases were obtained in anaerobic power after plyometric training in volleyball and basketball players (16). Gür detected that anaerobic power exhibited meaningful increase in the plyometric training group in the study performed on young male footballers (17). Döğüşcü suggested in his study performed on female volleyball players that there was an increase in anaerobic power data of the subject group as a result of plyometric training (18).

The findings obtained after examining the results are consistent with the literature. As it is known, plyometric exercises are the training forms that provide the development of a fast eruptive movement (1) for this reason we can say that the plyometric training performed increased anaerobic power and capacity meaningfully. Furthermore it was detected in this study that the impact of plyometric training performed 3 days a week on anaerobic power and capacity was more than the impact of plyometric training performed 1 day a week. The reason for this may be deemed as the impact of frequency of plyometric training on the development of anaerobic power.

REFERENCES

1. Bompa TO. Power Training For Sport: Plyometrics for Maximum Power Development. New Revised Edition, Coaching Association of Canada, 1996
2. Hoffman J. Physiological Aspects of Sport Training and Performance. USA: Human Kinetics, 2002.
3. Komi PV. Strength and Power in Sport. London: Blackwell Scientific Publications, 1992.
4. Chu DA. Jumping Into Plyometrics. 2nd Ed., USA: Human Kinetics, 1998.
5. Howard RL. Plyometric concept reinvent lower extremity rehabilitation. Biomechanics, 2004; September, s: 63–67.
6. Baechle TR and Earle RW. Essentials of Strength Training and Conditioning. China: Human Kinetics, 2000.
7. Wilkens L. National Basketball Conditioning Coaches Association. NBA Power Conditioning. USA: Human Kinetics, 1997, ISBN: 0-88011-687-0.
8. Sevim Y. Physical Fitness Training in Basketball [Basketbolda Kondisyon Antrenmanı]. 1st Edition. Ankara: Nobel Basımevi, 2003
9. Dündar U. Physical Fitness in Basketball [Basketbolda Kondisyon]. İkinci Baskı. Ankara: Nobel Basımevi, 2004.
10. Wilkens L. 14 Leading Strenght and Conditioning Coaches of the NBA. Condition The NBA Way. New York: Cadell & Davies, 1994, ISBN: 1-56977-886-8
11. Kibele A. Possible errors in the comparative evaluation of drop jumps from different heights. *Ergonomics*, 1999; Jul; volume 42, issue 7.
12. Tricoli V, Lamas L, Carnevale R, Ugrinowitsh C. Short-Term Effects On Lower-Body Functional Power Development: Weightlifting vs. Vertical Jump Training Programs. *J* Strength Cond Res, 2005; May; 19(2): 433-7.
13. Diallo O, Dore E, Duche P, Van Praagh E. Effect of plyometric training followed by a reduced training programme on physical performance in prepubescent soccer players. J Sports Med Phys Fitness, 2001; Sep;41(3): 342-8.
14. Matavulj D, Kukolj M, Ugarkovic D, Tihanyi J, Jaric S. Effects of plyometric training on jumping performance in junior basketball players. J Sport Med Phys Fitness, 2001; Jun; 41(2):159-64.
15. Tanita Corporation. Illinois, USA. Tanita BF-555, BF-556 Body Fat Monitor
    Instruction Manuel.
16. Duda, M. Plyometrics. A Legitimate Form of Power Training. The Physician and Sport Medicine. 1988; 16: 213-218
17. Gür E. The effect of specially designed pliometric training on anaerobic power performance in young football players. [Özel düzenlenmiş pliyometrik antrenmanların genç futbolcuların anaerobik güç performanslarına etkisi]. Fırat Üniversitesi – Yüksek Lisans Tezi, 2001
18. Döğüşçü M. Effect of Combined Strenght Training and Plyometric Traning Programmes on Vertical Jumping in Women Voleyball Players [Bayan voleybolcularda kombine kuvvet antrenmanı ile pliyometrik antrenman programlarının dikey sıçrama kuvvetine etkisi]. Gazi Üniversitesi – Doktora Tezi, 1999