

# THE EFFECT OF GROUND CONTACT TIME AND DROP HEIGHT ON WORK AND POWER OUTPUTS FOR DROP JUMP IN YOUTH TURKISH NATIONAL VOLLEYBALL PLAYERS

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## ABSTRACT

The aim of the study is to investigate the work and power capacities of drop jump performances according to drop jump height and contact time durations in Youth Turkish National volleyball players. 13 national volleyball players (Age=15.9±0.5 years) performed a series of drop jumps from heights of 20, 40, and 60cm. Two instructions, (a) "jump as high as you can" and (b) "jump high faster than your previous one", were given to the participants for each box heights. Two variables determined as moderate ground contact time (MC) and the shorter ground contact time (SC). Paired-Sample T-test was conducted to analyze the differences in power and work outputs in terms of contact time durations and Repeated-Measured ANOVA was also used to determine the differences according to box heights. While there were statistically significant differences between SC and MC in jumps performed for each drop heights, there was no significant difference in contact times according to box heights. The results of the study showed that drop height did not affect the contact times but made differences in maximum relative work and power. SC produced greater relative power than MC at all drop heights and greater relative works at 40 and 60cm box heights throughout the contact time duration.

**Keywords:** Relative maximum power, Relative work energy, Kistler.

## YILDIZ MİLLİ VOLEYBOLCULARIN DÜŞEREK SIÇRAMADA YERLE TEMAS SÜRELERİ VE DÜŞME YÜKSEKLİĞİNİN GÜÇ VE İŞ ÇIKTILARINA ETKİLERİ\*

### ÖZ

Çalışmanın amacı genç erkek voleybolcuların düşerek sıçrama performanslarında ortaya koyulan iş ve güç kapasitelerinin yerle temas süreleri ve düşme yüksekliklerine göre incelenmesidir. Çalışmaya dahil edilen 13 milli voleybolcu (Yaş=15.9±0.5 yıl) 20, 40 ve 60 santimetre yüksekliklerindeki kutulardan düşerek sıçrama uygulamışlardır. Voleybolculara her kutu yüksekliği için (a) "Sıçraya bildiğin kadar yukarıya sıçra" (b) "Önceki sıçramandan çok daha hızlı olarak en yükseğe sıçra" talimatları verilmiştir. Her bir kutu yüksekliğinde yapılan ikişer denemeden elde edilen değişkenler; normal temas süresi (NT) ve kısa temas süresi (KT) şeklinde oluşturulmuştur. Elde edilen güç ve yapılan iş değerlerinin temas sürelerine göre farklılıkları ilişkili örneklem için t-test ile, üç farklı kutu yüksekliğine göre değişimleri ise tekrarlı ölçümlerde ANOVA ile analiz edilmiştir. Her bir atlama yüksekliğinde yapılan atlamalarda kısa temas ve normal temas süreleri arasında istatistiksel olarak anlamlı farklar bulunurken, kutu yüksekliğine bağlı yapılan yerle temas sürelerinde anlamlı farklılık görülmemiştir. Çalışma sonuçları, düşme yüksekliğinin yerle temas sürelerine etki etmediğini ancak maksimum rölatif yapılan iş ve güç değerlerinde farklar oluşturduğunu göstermiştir. KT sırasındaki sıçramalar tüm kutu yüksekliklerinde NT sıçramalara göre daha fazla göreceli güç (W/kg) üretmiş, ve yine 40 ve 60cm yüksekliklerinde KT sıçramalarının yerle temas süresi boyunca NT grubuna oranla daha fazla iş (J/kg) ortaya koydukları görülmüştür.

**Anahtar kelimeler:** Rölatif maksimum güç, Rölatif iş, Kistler.

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## INTRODUCTION

Pliometric trainings is in the lead of training methods used to develop strength and power for athletes. Jump training is the main for these kinds of exercises based on the stretching-shortening cycle. The most frequently used one is the drop jump. In this exercise protocol, the athletes are asked to drop down and then immediately vertically jump. When the athletes drop down and contact with the ground, they perform the jump as high as possible with developing resistance to the ground and spending a certain amount of energy. In the literature, it has been reported that besides different techniques (hand-free, hands on hips or hands up, knee joint range of motion, etc.), drop height (the height of the box or place) and contact time have the effects on performance<sup>4,7,16</sup>. Walsh and colleagues reported that the contact time duration and the starting heights (20, 40, and 60 cm) of drop jump showed differences in terms of both maximum power and work performed<sup>15</sup>. It was thought that quadricep and hamstring muscles develop higher co-activation with the increasing drop height in dropping jumps, in addition to this it is expected that there is an increase in energy requirement and the work performed.

## MATERIAL AND METHOD

### Participants

13 male volleyball players (Xage=15.9±0.5 years), who play in Youth Turkish National Team for at least two years, participated in the study. Drop heights were determined as 20(DJ20), 40(DJ40) and 60 cm(DJ60) and two trials were performed for each box heights.

### Procedure

Kistler force plate (9260AA) was used to obtain power and work outputs of jumps (relative power and relative work). Before testing, athletes warmed

Peng and colleagues reported that neural activation of the rectus femoris muscle was greater in drop height at 60 cm than the heights at 20 cm and 30 cm, in their study<sup>12</sup>. On the other hand, in a different study investigating the optimal platform height in drop jump, 6 different platform heights (10 cm, 20 cm, 30 cm, 40 cm, 50 cm, 60 cm) were used and a significant difference was found between 10 cm and 60 cm when comparing the jump power and relative jump power according to platform height. When drop jump was performed from 10 cm, the jump power was found to be significantly higher than 60 cm<sup>1</sup>. In another recent study, Ruan and colleagues stated that there is no difference in neural activation due to the drop height even in other quadriceps muscles with rectus femoris<sup>13</sup>. While some studies stated that contact time durations can also have different effects on work and power outputs, such as drop height<sup>2,15</sup>, there are also other studies reporting contradictory results<sup>4,5</sup>.

The aim of the study is to investigate the work and power capacities of drop jump performances according to drop height and contact time durations in Youth Turkish National volleyball players.

up. All athletes were asked to take a vertical jump position (hand-free), and no instructions were given about the knee-joint range of motion. Two instructions, (a) "jump as high as you can" and (b) "jump high faster than your previous one", were given to the participants for each box height. Except a few attempts due to the mechanical faults, just one trial was given for each jump protocol. The first one of the 2 variables, obtained from two jump trials of each box height, was determined as moderate ground contact time (MC) and the second variable was shorter ground contact

time (SC). DJ20, DJ40 and DJ60 were determined for drop heights.

### Statistical Analysis

Paired sample T test was conducted to analyze the differences between short and moderate contact time durations for each of given box heights and

Repeated Measured ANOVA was also used to determine the differences among box heights (at 20, 40 and 60 cm) for relative power and work outputs. The normality was tested by Shapiro-Wilk test. Significance level was taken as 0.05.

## RESULTS

The athletes participating in the study showed a homogeneous distribution as to physical characteristics (n = 13, age: 15.9 ± 0.5 years, height: 1.93 ± 4.6 cm, weight: 80.2 ± 5.2 kg).

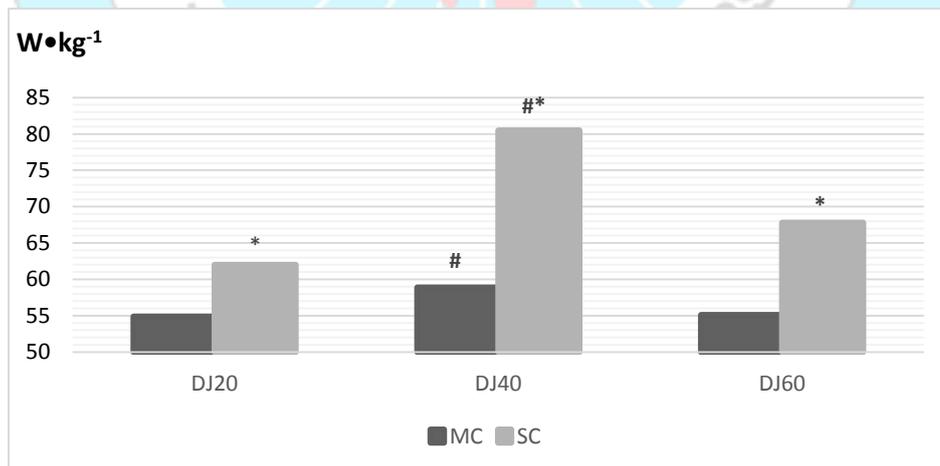
**Table 1.** Differences Among Ground Contact Time Durations

		MC	SC	t
Ground Contact Time (sec)	20 cm	0.46±0.1	0.31±0.6	5.75*
	40 cm	0.43±0.1	0.32±0.1	4.10*
	60 cm	0.44±0.1	0.34±0.1	2.89*

\*Statistical difference between MC and SC ( $p < 0.05$ ).

For each of drop heights, statistically significant differences were found between MC and SC trials ( $p < 0.05$ ), but there was no significant effect of different box heights on contact time

durations ( $p > 0.05$ ). Athletes performed shorter ground contact times in second attempts (SC) compared to the first one (MC) in all drop heights as expected ( $p < 0.05$ ) (Table 1).

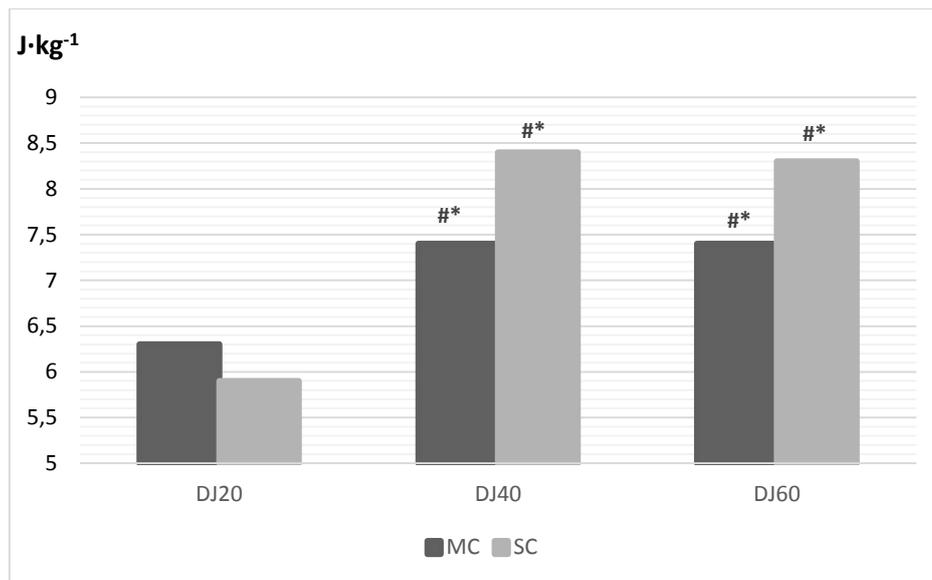


**Figure 1.** Relative Maximum Power (maxP) Differences Between MC and SC at Different Drop Heights. \*Significance of differences between MC and SC for the same drop height #significantly higher than other drop heights for the same contact time (MC or SC)

Although there was no significantly difference in ground contact time durations in terms of box heights, there were differences in relative maximum power and work ( $p < 0.05$ ). It was seen

that relative maximum power (maxP) outputs in SC was higher than in MC's for all drop heights. DJ40 had produced higher maxP values than

those at DJ20 and DJ60 for both MC and SC trials ( $p < 0.05$ ) (Figure 1.).



**Figure 2.** Relative Work Energy (Maxwork) Outputs Differences Between MC and SC at Different Drop Heights. \*Significance of differences between MC and SC for the same drop height #significantly higher than DJ20 for the same contact time (MC or SC)

Significant relative work differences were found between MC and SC at all drop heights with the exceptions of DJ20. It was seen that, for both SC and MC, the values of DJ40 and DJ60

were higher than DJ20 ( $p < 0.05$ ). Also relative maxWork values were higher in SC than MC at DJ40 and DJ60 ( $p < 0.05$ ) (Figure 2.).

## DISCUSSION

The purpose of this study was to examine the effects of drop jump trials performed at different contact times and varied box heights on the work and power outputs of young male volleyball players. It was seen that decreasing the contact time durations increases the potential to produce power and work. Although there were no differences in contact time due to the box heights, some differences were observed in work and power outputs. When similar studies were analysed, it was seen that the duration of contact time could change with the increase of drop height. Ball et al. (2010) stated that the contact time, at the same drop heights with the current study (20, 40 and 60 cm), increased based on the drop heights<sup>2</sup>. On the other hand, Hoffrenn et al. (2007) reported that a

decrease can be seen in the contact time as box height increases in youths<sup>10</sup>. On the contrary, it was observed that drop height did not have an effect on the contact times as a result of the current study. Atan et al. (2011) also showed that there was no difference in contact time for the drop height<sup>1</sup>. The reason for the similarity of the contact times at different drop heights may be due to the fact that the study population consists of elite volleyball players and they have the ability to demonstrate the performance without being affected by gravity because of their jump trainings similar to these jump protocols. It has previously been reported that performing a large number of jump executions provide both acute and chronic adaptations in the nervous system<sup>11</sup>. Another reason may be the

strength of the quadriceps muscles of the players participating in the study and accordingly they may not be affected by the different conditioning components associated with the jump. It is known that quadriceps muscles may be inadequate to cope with the impact force due to the weakness<sup>9</sup>. Also, the age range of the players can be the other reason. Variations in the performance outcomes depending on the drop heights may differ according to age range<sup>10</sup>. Finally, it has been reported that there are many different movement kinematics during landing and jump, and they can affect the power performance<sup>14</sup>. Bobbert (1990) reported that although the similar protocols were tried to be applied for all types of jump in such studies, the technique of the movement for jump kinematics is an uncontrollable variable<sup>4</sup>. In the current study, it is thought that the players may be able to maintain their performance, at different drop heights, because of the different movement and joint kinematics. In this study, although there was no difference in the ground contact time of the players due to the drop height, there were differences in the maximum relative power and work outputs. As previously reported, any manipulation on the jump technique can affect the work and power outputs<sup>15</sup>. Ball et al. (2010) reported that as the height of drop increases, the power potential increases<sup>2</sup>. In this study, it was seen that work and power production were higher in DJ40 and DJ60 compared to DJ20. The differences between DJ40 and DJ60 were found to be significant only in terms of work (J/kg).

In the literature, the number of the studies examining the effects of ground contact time on jump performance is less than the studies on the effects of drop height. In this study, the contact times for both jumps are slightly above the expected values. The range frequently reported in the literature is 0.2-0.3 seconds especially for the fast

contact times<sup>2</sup>. Related studies have reported that after an interval of 0.25 seconds, the ability to give the pliometric responses of the stretching-shortening cycle may weaken and the loss of strength may occur associated with it<sup>2,3</sup>. Although it was expected that the contact times of the volleyball players may be better since a quick jump is required to block the counter attack, the results contrary to expectations were found in this study. Further investigation of the contact time reaction in the maximal drop jump performance of the volleyball players is suggested for future studies. It has been noted that the duration of contact time is a more influential factor than the drop height to produce maximum power and work<sup>2</sup>. It has been emphasized that athletes should jump with an optimum time loss by keeping the ground contact time as short as possible<sup>8</sup>. The findings of this study were parallel to the literature and more power and work outputs were obtained during the jumps with short contact times. It has previously been reported that athletes may exhibit bilateral force differences during the jump, regardless of the jump technique<sup>2</sup>. For future studies, the differences of leg strength (right-left) may be measured and also evaluated before jumping.

## CONCLUSION

As a result, this study showed that the contact time was an effective variable on work and power outputs, while the drop height did not affect these outputs in volleyball players. It was supported with the literature that athletes could produce more power when they jump with keeping the contact time shorter. It is known that there are too many internal and external variables that can affect the jump performance outcomes. Although it is not possible to control all of these variables, controlling the variables of age, gender, sports branch and jump technique is important for the future studies.

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