INVESTIGATING OF THE RELATIONSHIP BETWEEN SPRINT AND JUMP PERFORMANCE WITH POWER PARAMETERS DURING PROPULSIVE PHASE OF FULL BACK SQUAT EXERCISE[3]

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ABSTRACT

The basic purpose of this study was to investigate of the relationships with sprint and jump performance of power parameters during propulsive phase of full back squat exercise and to determine which variable was associated with which loading loading. For this purpose, thirty-two men amateur athletes (age: 20.4 ± 1.98 years; height: 179.3 ± 7.23 cm; weight: 73.5 ± 9.85 kg) who actively involved in sports and have a basic level of force participated in voluntarily to this study. In the study, one repetition maximum (1RM) full back squat (SQ) strength test, vertical jump test, 5 meters and 30 meters sprint test were applied. The descriptive statistics and pearson correlation analysis was used for statistical evaluation of datas. According to statistical analysis results; It was concluded that there are mean level, negative and statistically a significant relationship between mean propulsive power (MPP) values (r = - ,607, p < 0.05) obtained at 70 % of 1RM load values and mean power (MP) values (r = - ,409; r = - ,454; p < 0.05, respectively) and peak power (PP) values (r = - ,445; r = - ,365, p < 0.05, respectively) obtained in the propulsive phase of full back squat exercise performed at 40 % and 70 % of 1RM load value with 5 meters sprint times. It was concluded that there are mean level, negative and statistically a significant relationship between PP values (r = - ,400; r = - ,355, p < 0.05, respectively) obtained at 40 % and 60 % of 1RM load values OG (r= - ,375; r = - ,394, p< 0.05) respectively) values obtained in the propulsive phase of full back squat exercise performed at 40 % and 70 % of 1RM load value with 30 meters sprint times. It was obtained that there are no statistically a significant relationship between power parameters during propulsive phases of full back squat exercise performed in different loads of 1RM and vertical jumping distance (p > 0.05).

Key Words: Full Back Squat, Propulsive Phase, Power, Sprint, Vertical Jump

TAM SQUAT HAREKETİNİN İTME EVRESİNDEKİ GÜÇ PARAMETRELERİ İLE SPRİNT VE SIÇRAMA PERFORMANSI ARASINDAKİ İLİŞKİSİNİN ARAŞTIRILMASI

ÖZET

Bu araştırmanın temel amacı; tam squat hareketinin itme evresi esnasındaki güç parametrelerinin sprint ve sıçrama performansı ile ilişkilerini araştırmak ve hangi değişkenin hangi yüklenme yoğunluğu ile ilişkili olduğunu belirlemektir. Bu amaç doğrultusunda aktif olarak spor yapan ve temel bir kuvvet düzeyine sahip 32 erkek amatör sporcu (yaş: 20.4 ± 1.98 yıl; boy: 179.3 ± 7.23 cm; vücut ağırlığı: 73.5 ± 9.85 kg) çalışmaya gönüllü olarak katıldı. Araştırmada, bir tekrarlı maksimal (1TM) tam squat (SQ) kuvvet testi, dikey sıçrama testi, 5 m ve 30 m sprint testleri uygulandı. Verilerin değerlendirilmesinde istatistiksel yöntemler olarak betimleyici istatistikler ve Pearson korelasyon analizi yapıldı. İstatistiksel analiz sonuçlarına göre; 5 m sprint zamanı ile 1TM yük değerinin % 40 ve 70'inde yapılan tam SQ hareketinin itme evresinde ulaşılan OG (sıraya göre r = - ,409; r = - ,454; p < 0.05) ve ZG (sıraya göre r = - ,445; r = - ,365, p < 0.05) değerleri ve 1TM yük değerinin % 70'inde ulaşılan OİG değerleri (r = - ,607, p<0.05) arasında orta düzeyde, negatif ve istatistiksel olarak anlamlı bir ilişki olduğu sonucuna ulaşılmıştır. 30 m sprint zamanı ile 1TM yük değerinin % 40 ve 70'inde yapılan tam SQ hareketinin itme evresinde ulaşılan OG (sıraya göre r= - ,375; r = - ,394, p<0.05) ve 1TM yük değerinin % 40 ve 60'ında ulaşılan ZG değerleri (sıraya göre r = - ,400; r = - ,355, p<0.05) arasında orta düzeyde, negatif ve istatistiksel olarak anlamlı bir ilişkili olduğu sonucuna ulaşılmıştır. Buna karşılık dikey sıçrama mesafesi ve 1TM'nin farklı yüklerinde yapılan tam SQ hareketinin itme evresindeki güç parametreleri arasında istatistiksel olarak anlamlı bir ilişkinin olmadığı elde edilmiştir (p>0.05).

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INTRODUCTION

The power characteristics used to identify some important skills that contribute to maximal human efforts in sporting and other physical activities (20) are considerably important for several sports that require a high work rate (45). Although at times the terms *"Power''* and *"Strength''* are used interchangeably, this is not correct because of the fact that power has a time component. Therefore, if two athletes have similar maximal strength, the one who expresses strength at a higher rate (higher velocity or shorter period of time) will have a distinct advantage during performance of anaerobic sports (36). Power (P), one of the most important factors in athletic performance (11, 32, 46), is mechanical quantity that expressed as the time-wise rate of a doing work (action) (15) and generally depends on the ability to produce maximal force as possible as (42). That is to say, for several athletic movements the success of performance is largely affected by how much force and power is applied toward objects such as ground, ball, or sporting equipment. Also, according to Newton and Kraemer (32) power is determined by multifaceted strength qualities rather than any single aspect of strength. Particularly, the ability to develop high force rapidly, and the ability to continue producing high force during high velocity are paramount to maximize power. The masses that must be manipulated during a given task in sports range from a part of the body such as arms in throwing, legs in kicking, or whole body in jumping to opposition bodies such as tackling in football (33). Therefore, power can be determined for a single body movement a series of movement or, as in the case of aerobic exercise, a large number of repetitive movements. Also, power can be determined instantaneously at any point in a movement or averaged for any portion of a movement or bout of exercise (25).

During power assessment different parameters have been used, the most common being the mean power (MP), mean propulsive power (MPP) and peak power (PP). It was found that the load that maximizes the mechanical power output (P_{max} load) depend on parameters used such as MP, MPP and PP (38, 40). These parameters can be used to determine a central variable considered important to power and performance in explosive tasks, that variable is the training load that maximizes the mechanical power output of muscle (5, 11, 38).

Vertical jump testing is commonly used to measure improvements in the vertical jump for sports branches such as basketball, handball and volleyball in which jumping ability helps performance and as a general measure of lower body power in sports such as football that require high levels of lower body power (21). It is stated that there are a considerably close relationship between sprint and jumping performance (35). Sprint is an ability to run at maximal or close maximal velocity in a shortest time period (4). The ability to generate a high maximal sprint velocity is an important indicator of success in many sports branches (6). Therefore, sprint ability is a complex ability that requires proper motor coordination between joints and muscles (12). Sprint ability over very short distances (5 or 10 m) is considered by many researchers and practitioners to require specific strength qualities and running technique, and generally is accepted that shorter sprints require a greater contribution of concentric muscle contractions and knee extensor activity (29).

In literature, there are only one study to investigate relationships between short sprint performance with power parameters in the full back squat exercise and carried out in U21 soccer players by Lopez-Segovia *et al.,* (27). Apart from this, there are not any study. Nevertheless, some studies were examined that available relationships between short sprint performance with different strength and power measurements in isoinertial exercises (a constant external load), but it was seen that examined relationships between sprint times with some parameters during jumping exercises or one repetition maximal (1RM) strength in this studies

More recently, it was seen that researches have focused on gaining an understanding of the which parameters that can best explain jump performance in several sports. However, excepting a study carried out by Requena *et al.,* (37), there are no available a study to examine relationships between jumping distance with power parameters gained during propulsive phase of full squat exercise applied at different loads. In studies, it was seen that relationships between jumping ability with parameters during bounce phase of counter movement and squat jump exercises were investigated.

Sprint and jump performance are accepted as the most significant components of many sports like soccer, basketball and handball and these components are quite effective for achievement in this sports. So, most of the training methods are applied to increase the strength and power in sports by developing the physical performance and in this way the performance of sprint and jump in team sports (16, 41). Considering studies in literature, generally, it can be seen that examining relationships among sprint times and jump performances with 1RM strength value. But, there are no studies researched with details about the relationships between propulsive phase in the full back squat exercise (i.e. the parameters of power during concentric movement) with 5 and 30 meters sprint times and jumping performance. In this study, thus, it was purposed to find out the relationships between the power parameters during propulsive phase of full back squat (SQ) exercise with 5 - 30 meters sprint times and vertical jump performance and to determine which variable is in relation with which loading intensity. The results that will be obtained from this study; will contribute significantly in improving sprint times, while preparing jump exercises, while preparing a training program for trainers and sports literature and it is thought to be significant in bridging the gap in current literature.

METHOD

Subjects

Thirty-two men amateur athletes (age: 20.4 ± 1.98 years; height: 179.3 ± 7.23 cm; weight: 73.5 ± 9.85 kg) who actively involved in sports and have a basic level of force participated in voluntarily to this study.

Data Collection Tools

In this study, subject’s height and weight values was determined using a Seca 769 electronic measurement tool (Seca Corporation Hamburg, Germany). 1RM strength values in full back squat exercise of subjects were obtained using smith machine (Esjim, Eskisehir, Turkey) which a stable vertical plane. Free weights (1, 1.25, 2.5, 5, 10, 15 and 20 kg) which controlled weights with a electronic device was used for determining 1RM strength values in the full back SQ exercise using smith machine.

T-Force device (Ergotech Murcia, Spain) was used for determining power parameters during propulsive phase of full back SQ exercise that different loads were implemented (figure 1). This system’s use is particularly suitable for typical weight-lifting exercises or any resistance training exercise where it is necessary to overcome, against gravity, a load (constant mass) that move along the vertical axis. The system consists of electromechanical equipmant (velocity sensor and interface; figure 1a, 1b), a hook attached to weight training barbell (figure 1c), and a computer program (T-Force software; figure 1d) governing the hardware. It is the sensor that measure the velocity of moving loads. The transducer is usually placed on the floor and inside the aluminum housing, a high precision tachogenerator measure how fast the 2 meter cable extends or retracts. That is, the sensor provides a voltage proportional to the velocity with which the cable is moving. The communications interface consists of an electronic data acquisition board equipped with a 14-bit resolution converted. The connection to the computer is via a USB port, allowing a very fast and safe data transfer. The sampling frequency at which data are acquired is fixed at 1.000 Hz, that is you get a instantaneous velocity daya every millisecond. The software is automatically calculates the relevant kinetic and kinematic parameters as force, power and velocity of every repetition in resistance training and displays them numerically and graphically on screen. In addition, the software provides auditory feedback and stores data on disk for analysis (38, 39, 40).

5 and 30 meters sprint durations of subjects were obtained by using a portable photocell system (Newtest Powertimer Model 300s, Oy, Finland). A tape measure was used for measure to vertical jump height.

Data Collection Process

Data collection process in this study was carried out in three different period. First period, 1RM strength value in full back SQ exercise and physical characteristics of subjects were determined and weights which corresponding different percentages (20, 30, 40, 50, 60, 70, 80, 90, and 100 %) of 1RM were recorded calculating. In second period, full back SQ exercise was performed at weights calculated previously in different percentages of 1RM. Propulsive phases during full back SQ exercise of subjects in the applied loads were obtained as mean power (MP), mean propulsive power (MPP) and peak power (PP). In third and final period, 5 - 30 meters sprint and vertical jump tests were applied.

Information about how data collected during the study are described as detail in case of subtitles.

One Repetition Maximal Strength Test

1RM strength values in full back SQ exercise of subjects were obtained according to test procedure designed by Beachle *et al.,* (7). Processes applied in this test procedure was detailedly explained as below.

1. After a 10 minutes general warm-up, the subjects warms up by performing repetitions with a load that allows 5 to 10 repetitions,
2. One minute rest was given,
3. Estimate a warm-up load that allows the subject to complete three to five repetitions by adding a load between 14 and 18 kg to load used in step 1,

1a

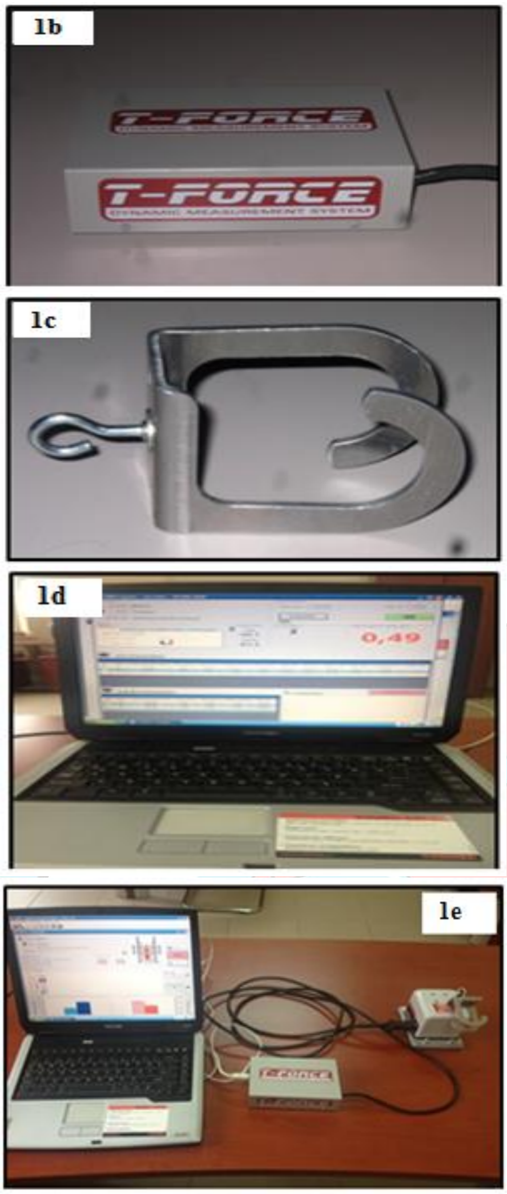

Figure 1. T-Force dynamic measurement system: (1a) velocity sensor, (1b) interface, (1c) a hook attached to weight training barbell, (1d) T-Force software, (1e) set up of the system

4. Two minutes rest was given,
5. Estimate a near maximal load that will allow the subject to complete two or three repetitions by adding a load between 14 and 18 kg to load used in step 3,
6. Two to four minutes rest was given,
7. The subject performs a 1RM attempt by increasing the load used in step 5 by 14 to 18 kg,
8. Two to four minutes rest was given,
9. If subject succeed in lifting the load in step 7, the load has been resumed increasing in proper proportions. But, if the subject fails the 1RM attempt, decrease the load by removing 7 to 9 kg, and have the subject perform one repetition,
10. Two to four minutes rest was given,
11. Continue increasing or decreasing load until the subject can complete 1RM with appropiate technique. The subject's 1RM value was maximally obtained within five attemps.

Full Back Squat Exercise Procedure

After 1RM values of subjects who participated in study was determined, lifting measurements in different percentages of 1RM in full back SQ exercise was carried out in a fitness center. Full SQ exercise was performed using a prosedure which designed by Earle and Beachle (14). In procedure, the subject grasped the barbell with a closed, pronated grip slightly wider than shoulder width and the barbell was placed above the posterior deltoids (high bar position). The feet should be slightly wider than shoulder width and indicated slightly outward when the subject begins the descent. The subject reached the lowest point in the descent when the top of the thighs are parallel to the ground, and the barbell lifted in a continuously motion without assistance. For safety, at least two observers were stood on either side of the barbell and followed the bar during the descent and ascent. It was emphasized that subjects should breathe out when lifting the barbell and breathe in when lowering the barbell during implementing of full back squat exercise. During lifting to perform in full SQ exercise, subjects were performed to three repetitions for light loads, and two repetitions for middle loads and the best values were recorded for statistical analysis. Also, one repetition was performed for heavy loads. For rest times, it was given two to three minutes for light and middle loads, and three to five minutes for heavy loads.

Sprint Tests

After general a warm up activity of ten minutes, athletes were applied the two times 5 - 30 meter sprint tests from a statical position (behind 0 meter of first photocell sensor) with three minutes rest period to ensure a full recovery on the athletics running track. The best 5 and 30 meter sprint times of athletes were reported for statistical analysis.

Vertical Jump Test

After general a warm up activity of ten minutes, athletes were applied the vertical jump test in a indoor sports hall. Firstly, in front of the test platform was determined to standart arm lenght of athletes and then it was dictated that jumps as high as possible, but should fall on the ground without bending his knees after the jump. The end of the test, it was determined to difference between player's arm length with vertical jump height and vertical jump height was recorded as centimeters. Athletes were performed two times vertical jump tests by giving adequate rest periods and the best vertical jump height were reported for statistical analysis.

Statistical Analysis

To statistical analysis of data was used the SPSS 16.0 statistical package program. Physical, performance and power parameter (MP, MPP and PP) values during propulsive phase of full back SQ exercise applied at different loads of subjects were determined as mean, standart deviation, minimal and maximal with descriptive statistics. Pearson correlation analysis technique was used to determine correlations between 5 and 30 meters sprint times and vertical jump distance with power parameters during propulsive phase of full back SQ exercise. The significance level for all statistical analysis were accepted as $p < .05$.

RESULTS

The descriptive statistical values belonging to physical and performance values of participants were given on table 1, and the values belonging to power parameters during propulsive phase (concentric phase) of full back SQ exercise applied at different loads were given on table 2.

Table 1. Physical and Performance Values of Subjects

Variables	n	Mean	Standart Deviation	Minimal	Maximal
Age (years)	32	20,4	1,98	18	24
Height (cm)	32	179,3	7,23	164	191,5
Weight (kg)	32	73,5	9,85	54,7	99,7
5 meter sprint (sec)	32	1,11	0,73	1,01	1,29
30 meter sprint (sec)	32	4,39	0,18	3,97	4,77
Vertical jump (cm)	32	50,25	7,50	34	69
1RM full back squat strenth (kg)	32	101,0	18,7	70	150

Table 2. Power Parameters Values During Propulsive Phase of Full Back Squat Exercise

1RM Load		Power Parameters (W)		
(%)	**n**	**MP**	**MPP**	**PP**
20	32	125,2 (± 26,6)	143,4 (± 30,2)	718,2 (± 152)
30	32	152,5 (± 31,6)	188,3 (± 24,3)	926,1 (± 244,8)
40	32	197,2 (± 55,1)	280,1 (± 85,1)	1129,4 (± 275,8)
50	32	226,8 (± 63,4)	329,3 (± 131,1)	1341,6 (± 393,5)
60	32	232 (± 56,2)	337,3 (± 99,9)	1357,8 (± 391,9)
70	32	236,3 (± 72,1)	336,2 (± 100,5)	1382,5 (± 500)
80	32	212,7 (± 54)	308,4 (± 100)	1311,2 (± 498,3)
90	32	197,7 (± 55,5)	230,7 (± 65)	1288,3 (± 441,7)
100	32	162,1 (± 46,4)	164,5 (± 59,4)	1023 (± 449,7)

MP: Mean Power; MPP: Mean Propulsive Power; PP: Peak Power

The correlation results belonging to the relationships between power parameters (MP, MPP, PP) obtained during propulsive phase of full back SQ exercise which were applied at different load and 5 m sprint times of participants were given on table 3. When table is analyzed, it was seen that there is a significant relationship as average, negative and statistical between MP (r = - ,409, p < 0.05; r = - ,454, p < 0.05, respectively) and PP (r = - ,445; r = - ,365, p < 0.05, respectively) values obtained during propulsive phase of full back SQ exercise applied at 40 and 70 % of 1RM load with 5 meter sprint time. Similarly, it was seen that there is a significant relationship as average, negative and statistical between 5 m sprint times and MPP value (r = - ,607, p < 0.05) obtained at 70 % of 1RM load.

Table 3. Pearson Correlation Results Belonging to the Relation Between Power Parameters During Propulsive Phase of Full Back Squat Exercise and 5 Meter Sprint Times

1RM Load (%)	n	MP - 5 Meter Sprint		MPP - 5 Meter Sprint		PP - 5 Meter Sprint	
		r	**p**	**r**	**p**	**r**	**p**
20	32	- ,196	,283	- ,138	,450	- ,123	,501
30	32	- ,346	,052	- ,292	,105	- ,325	,070
40	32	- ,409*	,020	- ,127	,488	- ,445*	,011
50	32	- ,087	,636	- ,123	,501	- ,249	,170
60	32	- ,202	,266	- ,214	,239	- ,261	,149
70	32	- ,454*	,009	- ,607*	,000	- ,365*	,040
80	32	- ,163	,373	- ,129	,480	- ,054	,769
90	32	- ,334	,062	- ,312	,082	,016	,931
100	32	- ,159	,385	- ,187	,305	,083	,651

* p < 0.05; MP: Mean Power; MPP: Mean Propulsive Power; PP: Peak Power

The correlation results belonging to the relationships between power parameters (MP, MPP, PP) obtained during propulsive phase of full back SQ exercise which were applied at different loads and 30 meter sprint times of participants were given on table 4. When table is analyzed, it was seen that there is a significant relationship as average, negative and statistical between PP (r = - ,400; r = - ,355, p<0.05, respectively) obtained at 40 - 60 % and MP (r= - ,375; r = - ,394, p< 0.05, respectively) obtained during propulsive phase of full back SQ exercise applied at 40 and 70 % of 1RM load value with 30 meter sprint time. However, there is no a statistically significant relationship between MPP during propulsive phase of full SQ exercise applied at different loads of 1RM and 30 meter sprint times (p > 0.05).

Table 4. Pearson Correlation Results Belonging to the Relation Between Power Parameters During Propulsive Phase of Full Back Squat Exercise and 30 Meter Sprint Times

1RM Load (%)	n	MP - 30 Meter Sprint		MPP - 30 Meter Sprint		PP - 30 Meter Sprint	
		r	**p**	**r**	**P**	**r**	**P**
20	32	- ,132	,471	,075	,682	,040	,828
30	32	- ,163	,373	- ,129	,482	- ,216	,236
40	32	- ,375*	,035	,297	,099	- ,400*	,023
50	32	- ,248	,171	- ,139	,449	- ,292	,105
60	32	- ,349	,050	- ,331	,064	- ,355*	,046
70	32	- ,394*	,026	- ,314	,080	- ,318	,076
80	32	- ,069	,706	- ,020	,912	,038	,838
90	32	- ,290	,108	,076	,681	- ,230	,205
100	32	- ,192	,294	- ,143	,436	- ,278	,123

* $p < 0.05$; MP: Mean Power; MPP: Mean Propulsive Power; PP: Peak Power

The correlation results belonging to the relationships between power parameters (MP, MPP, PP) obtained during propulsive phase of full back SQ exercise which were applied at different loads and vertical jump height of participants were given on table 5. When table is analyzed, there is no a statistically significant relationships between power parameters during propulsive phase of full SQ exercise applied at different loads of 1RM and vertical jump distance ($p > 0.05$) were seen.

Table 5. Pearson Correlation Results Belonging to the Relation Between Power Parameters During Propulsive Phase of Full Back Squat Exercise and Vertical Jump Performance

1RM Load (%)	N	MP - Vertical Jump		MPP - Vertical Jump		PP - Vertical Jump	
		r	**P**	**r**	**p**	**r**	**p**
20	32	,256	,157	,099	,591	,219	,228
30	32	,170	,351	,127	,488	,054	,770
40	32	,187	,304	- ,117	,524	,170	,354
50	32	,109	,553	,017	,926	,154	,401
60	32	,227	,212	,342	,056	,255	,159
70	32	,225	,215	,076	,678	,114	,534
80	32	- ,131	,475	- ,076	,681	- ,188	,302
90	32	,150	,412	- ,100	,586	- ,008	,964
100	32	- ,048	,794	- ,040	,827	,061	,741

DISCUSSION

One repetition maximal strength is the maximal strength or maximal load which an individual can lift at once in an exercise (8). In this study, full back SQ exercise was performed in order to determine 1RM values of subjects and 1RM values of subjects were obtained on average 101 (±18.7 kg). Considering studies in literature, in studies carried out by Garcia-Pallares *et al.,* (17) and Sanchez-Medina *et al.* (39) obtained that mean 1RM values in full back SQ exercise of subjects who are doing strength training was 100.4 (± 21.8 kg) and 102 (±22 kg), respectively. Parejo-Blanco *et al.* (34) found the 1RM values in full SQ exercise of profesional soccer players which they divided the players in two groups who have 15-30% average speed loss as 93.3 kg for 15% group and

98.1 kg for 30% group. 1RM values obtain in mentioned studies and values obtained from this study were seen to be similar to each other. Though, when considering participant groups, while expecting 1RM values to be higher, these values seem to be lower. This may result from test procedure in mentioned studies are not in accordance with traditional methods but in accordance with lift velocity (velocity factor). In current study, 1RM values in full SQ exercise was obtained according to traditional methods.

Unlike the results of this study, Alcaraz *et al.,* (1) obtained that sprinters who have at least 2 year of strength training and 6 years of sprint training experience have, average on, 199.7 (± 59.1 kg) 1RM values in SQ exercise. Zink *et al.,* (47) found that 1RM average values of participants who have at least 2 years of SQ training history was 175.1 (± 30.6 kg). In studies carried out by Cotterman *et al.,* (10) and Masamoto *et al.,* (30), it was found that 1RM values of healthy males were as 171.5 (± 35.7 kg) and 139 (± 29.3 kg), respectively. In studies related to elite soccer players, average 1RM values in squat exercise were found as 171.7 kg (44) and 119.5 kg (37). In addition, while average 1RM values in squat exercise of NCAA 1. league soccer players were found as 121±22.5 kg (43), 1RM value of players in Celtic U17 soccer club were found as 129.1±11 kg (31). It was obtained that 1RM values of 1. league soccer players (9) and judoists who have at least 18 months of strength training experience (22) in SQ exercise was 170 (± 21.7 kg) and 129.8 (± 19.4 kg), respectively. In a study carried out by Izquierdo *et al.,* (23), average 1RM values in squat exercise was obtained as 157 (± 18 kg) for weight lifters and 134 (± 18 kg) for bicyclers. As can be seen, the results obtained from mentioned studies are higher than results in current study. This difference may result from the procedures applied or the differences between individuals in studies. That is, participants in this study are amateur athletes who have have basic strength levels and full back SQ exercise were applied as procedure. In studies, participants were applied half SQ exercise, and participants consisted of individuals who have been performing strength training for long time or senior athletes.

In this study related to amateur athletes who are actively perform exercise in different sport branches and have a basic strength level was found that MPP values at 70 % of 1RM load value together with MP and PP values at full back SQ exercise performed at 40 % and 70 % of 1RM load value have an average negative relation with 5 meter sprint duration, and there is no a statistically significant relation between power parameters in full back SQ exercise performed with other loads and 5 meter sprint duration. Considering 30 meter sprint performance, it was found that MPP values reached at 40 % and 60 % of 1RM load value together with MP values obtained during propulsive phase of full back SQ exercise performed at 40 % and 70 % of 1RM load value have an average negative relation with 30 meter sprint times, apart from that, none of power parameters during propulsive phase of full back SQ exercise performed with other loads have statistically significant relation with 30 m sprint times. Considering studies in literature, except that the study which carried out in U21 soccer players by Lopez-Segovia *et al.* (27) and investigate relationships between short sprint performance with power parameters at full back SQ exercise, there is no study investigated to the relationship between power parameters during propulsive phase and sprint performance. Even so, some studies were investigated the relationship between different power and strength measurements in izoinertial exercises (a constant external load) and short sprint performance. But, this studies are towards investigating available relations between sprint durations with some parameters in jump exercises or 1RM strength.

Lopez-Segovia *et al.,* (27) found that MP value in full SQ movement performed with 70 kg of external load are mostly in relation with sprint durations. In addition, they found a significant correlation between MP values in full SQ movement performed with 30 and 40 kg of external load and 10 meter sprint times. But except that, they couldn't find any significant relation between sprint times and power parameters in full back SQ exercise at different loads. It was found that PP output have only significant correlation at 20 and 30 kg with sprint times. Similarly; in an another study by Lopez-Segovia *et al.,* (26), found that there is a significant correlation between 10, 20 and 30 meter sprint times with MP values during full back SQ exercise performed at different loads (30, 40, 50 and 60 kg). In addition, it was noticed that sprint times and PP parameter have a strong relationship.

In a study carried out on semi-professional soccer players by Requena *et al.* (37) investigated that relationships between MPP and PP values which were reached through an external load which is equaled to 50, 75, 100 and 125 % of body weight in half-squat exercise with 15 meter sprint times and obtained that all the measurements in half-SQ exercise show significant relationships with 15 meter sprint times. It was determined that the strongest relationship observed between half-SQ exercise and 15 meter sprint times is MP which is 75 % of body weight and MPP. Though external load applied is determined according to body weights of participants, it can be seen that obtained results are partly similar to results of current study. In this study, a statistically significant relationship between MP, MPP and PP parameters obtained at 70 % of 1RM load value with 5 meter sprint time were obtained.

In this study, it was obtained that there was no statistically significant relationship between MP, MPP and PP parameters during propulsive phase of full back squat exercise which was performed at different loads of 1RM and jump performance ($p>0.05$) Considering studies in literatüre, Requena *et al.* (37) investigated that relationships between jump performances with MPP and PP values which were reached through an external load which is equaled to 50, 75, 100 and 125 % of body weight in half-squat exercise of 1. league soccer players and they found that jumping height and these variables (PP, MPP) have significant relationships. In addition, it was indicated that MP parameter which was obtained at only 50 % of body weight is not a significant relationship with jump measurements. On the contrary, it was found that the strongest relationship is MP which was obtained at 75 % of body weight. These results don't comply with the results obtained in this study. This difference may result from the method applied.

Marques and Gonzalez-Badillo (28) found that MP and PP parameters during propulsive phase with jump height have an average relationship, but PP is not the most related variable. On the other hand, in a study with females that Ashley and Weiss (3) carried out, they found that PP during concentric phase of squat jump is the most related variable with jump. Similar results were found by different researchers. Dowling and Wamos (13) found a strong relation between countermovement jump height and PP during concentric phase of jump and suggested that positive PP is the strongest indication of vertical jump performance. In a later study Gonzales-

Badillo and Marques (18) demonstrated that there is a significant relationship between MP and PP values which was produced during concentric phase of vertical jump and countermovement jump height. Harman *et al.,* (19) found that PP and countermovement jump height have considerably relationships when participants use their arms, but MP has lower relationship. Kawamori and Haff (24) suggest that PP is one of the key indicators of performance in different movements. On the contrary, Aragon-Vargas and Gross (2) state that jump performance has a significant relation with MP output.

This study is the first study which relationships among short sprint, jump performance and power parameters (MP, MPP, PP) during propulsive phase of full back squat exercise applied at different loads are investigated with details. Therefore, it could be said that results gotten in this study was too important for sports science literature. In this study, maximal power output was reached at 70 % of 1RM load value for MP and PP parameter during propulsive phase of full back SQ exercise applied in different loads and for MPP parameter, it was reached at 60 % of 1RM. In addition, it was obtained that 5 m sprint times are statistically significant relationships with MP and PP values at 40 % and 70 % of 1RM and MPP value at 70 % of 1RM load. In addition, there is statistically significant relationship between 5 meter sprint time with MP and PP at 40 - 70 % and MPP values attained at 70 % of 1RM load; 30 meter sprint time with MP attained at 40 - 70 % and PP values during propulsive phase of full back squat exercise which was lifted at 40 - 60 % of 1RM load. On the other hand, there is no statistically significant relationship between vertical jump height and power parameters during propulsive phase of full back SQ exercise applied at different 1RM loads. Consequently, for both MP and PP parameters, because maximal power outputs are reached at 70 % of loading intensity of 1RM and this intensity has a negative relationship with 5 and 30 meters sprint performance for both MP and PP, trainings that will be carried out for developing sprint performance can be applied at this loading intensity.

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