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A Comparative Study of Muscle Strength and Anaerobic Power of the Young National and National Junior Wheelchair Basketball Players

Genç Milli ve A Milli Tekerlekli Sandalye Basketbol Sporcularında Kuvvet ve Anaerobic Gücün Karşılaştırmalı Çalışması

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Summary

Objective: The aim of the study was to compare the body composition, anaerobic power and isokinetic muscle strength of the shoulder rotators of the young National and National Junior Male Wheelchair Basketball players.
Materials and Methods: A total of 28 male wheelchair basketball players aged between 15 and 31 years participated in the study. The age, height, weight, body mass index, and lean body mass of both the teams were compared, and isokinetic strength testing of the internal shoulder and external rotator muscles was performed at speeds of 60°/s and 180°/s in the scapular plane. The Wingate anaerobic power test (30 s) was performed using an upper body ergometer. The results were compared using the Mann-Whitney U test.
Results: There were statistically significantly difference in isokinetic strength and body composition of two teams ($p<0.05$). However, there was no difference in the results of the Wingate anaerobic power test between the two groups ($p>0.05$).
Conclusion: We believe that this difference in strength originates from the muscle kinetics of wheelchair propulsion.
Key Words: Anaerobic power, shoulder, strength, wheelchair basketball

Özet

Amaç: Bu çalışmada amaç Genç milli ve A Milli Tekerlekli Sandalye Basketbol sporcularının omuz rotatorlarının izokinetik kuvvetini, anaerobik gücünü ve vücut kompozisyonlarını karşılaştırmaktır.
Gereç ve Yöntem: Çalışmaya 15-31 yaşında toplam 28 tekerlekli sandalye basketbol takımı sporcusu katıldı. Takımların yaş, boy, vücut ağırlığı, vücut kitle indeksi, yağsız vücut ağırlığı karşılaştırıldı, omuz ekleminin internal ve eksternal rotatörlerine skapular düzlemde 60°/sn ve 180°/sn hızlarda izokinetik kuvvet testleri yapıldı. Üst ekstremite ergometresinde. Wingate anaerobik güç testi (30sn) uygulandı. Sonuçlar Mann-Whitney U testi ile karşılaştırıldı.
Bulgular: Takımların izokinetik kuvvet ve vücut kompozisyonları arasında fark istatistiksel açıdan anlamlıydı ($p<0,05$). Fakat Wingate anaerobik güç testleri iki takım arasında faklı değildi ($p>0,05$).
Sonuç: Kuvvetteki farklılığın tekerlekli sandalyeyi sürme ile ilişkili kas kinetiğinden kaynaklandığı düşünüldü.
Anahtar Kelimeler: Anaerobik güç, omuz, kuvvet, tekerlekli sandalye basketbolu

Introduction

Success in a sport requires acquiring competitive advantages and developing capacities related to that sport (1). Wheelchair basketball requires the ability to use wheels, rebound, pass the ball, shoot the ball over one's head, and perform intensive activities (2,3,4).

The sitting position of the wheelchair player influences his or her muscle strength and balance. Players generally have kyphotic posture, such that their upper bodies are flexed, their scapulae are protracted, and both humeri are internally rotated. This sitting position is also characterised by scapular protraction and internal rotation of the humerus, which negatively influence shoulder movement (5).

The ability of the player to maneuver and control his or her wheelchair is important. Thus, the player's success on the court is related to the strength of his or her upper extremity muscles (6,7). Moderate to high levels of repetitive shoulder muscle activity are present during wheelchair propulsion and

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place significant demands on the shoulder muscles when the activity is performed for more than 10-20 minutes (8). The rotator cuff and deltoid muscles and the long head of the biceps brachii are shoulder stabilisers. Some of the muscles may get stronger as a result of long-term wheelchair propulsion. Consequently, stabilising components of the shoulder are changed,thus, imbalance may occur in the shoulder joint (9). Numerous studies have demonstrated that muscular imbalance in the shoulder causes pain and injury in wheelchair users (10). Changed movement patterns may lead to the supraspinatus muscle to impinge between the humeral head and acromion, result in pain and inflammation and possibly cause rotator cuff tears (9).

Performance of wheelchair sportsmen on the court is more closely related to their anaerobic capacity than their aerobic capacity (11). The player needs to repeatedly move the wheelchair without sufficient rest. Thus, the player's recovery time is quite limited. The players need to stop and move frequently. Because this movement is fast and forceful, it also requires both anaerobic and aerobic capacities (12).

Physical fitness assessment for upper body of wheelchair basketball players is important in order to evaluate their physical condition. This helps health care team to obtain individual baseline data which is needed for developing an appropriate exercise program. The aim of the study was to determine adaptations which are obtained from regular training results of young and junior male wheelchair basketball players. For this purpose, this study compares the body composition, anaerobic power and isokinetic muscle strength of the shoulder rotators in the young national and national junior male wheelchair basketball players.

Materials and Methods

Participants

This study included 28 male players of a basketball team. Subjects' height and weight were measured without shoes, and the subjects were asked to wear light clothing. Height was measured with a Harpenden stadiometer (Critikon Service Centre, Reading, UK) to the last complete 0.1 cm; weight was measured with a Soehnle digital electronic scale to the last complete 0.1 kg. The subjects were divided into two groups. Young national players present group I (n=14) and national junior players comprise group II (n=14). In Group I, ten players had poliomyelitis, 1 subject was with spinal cord injury (SCI), and 3 subjects with lower limb amputation. In group II, 7 players had poliomyelitis, 5 subjects was with SCI, and 2 subjects with lower limb amputation. Only the individuals that were free of instability, impingement or shoulder joint problems were included in the study. The right side was dominant in all of the players. The assessed parameters included the anaerobic power and peak shoulder rotator isokinetic torques in the scapular plane.

Design and Procedures

Before data collection began, the participants read and signed a consent form approved by the Hacettepe University ethics committee (Protocol # LUT06/50-31).The players' age, body height, body weight, anaerobic power and shoulder rotator muscle strength were assessed. To determine body composition in the players, the Futrex-5999/XL body composition analyser (13) (v 8.3, Futrex, Inc., Gaithersburg, Md) was used. Isokinetic shoulder rotator muscle strength tests were performed in the scapular plane at speeds of 60°/s and 180°/s (14) (Cybex Norm, Lumex Inc., Ronkonkoma, NY., 1997). After the Cybex Upper Body Ergometer (Cybex Inc., Ronkonkoma, New York, USA) was warmed up at a speed of 120°/s, 4 submaximal trials and 1 maximal trial were performed. Both groups were given isokinetic strength tests in the scapular plane. In a sitting position, the glenohumeral joint was adjusted to 30-45° of flexion and 45° of abduction. In both groups, this test was performed at speeds of 60°/s and 180°/s (5 and 10 repetitions, respectively). The peak torque (Nm), total work (J), acceleration time (s), endurance and deficit ratio were evaluated (15-17). To assess anaerobic power, the Wingate anaerobic power test (30 s) (WANT) protocol was used (Monark, Ergomedic 891E, Monark Exercise AS, Sweden) (18).

Statistical Analyses

The Mann-Whitney U test was used to compare the results. Non-parametric tests were used because the data were non-normally distributed.

Results

The ages, body heights, and body weights of the players and group-related data are shown in Table 1. There were statistically significant differences between the two groups in body fat percentages, fat weights and body mass indices ($p>0.05$) (Figure 1). Young national wheelchair basketball players (group I) were older, had more body weight and sports experience ($p<0.05$).

Right shoulder internal rotator acceleration times in group I were shorter compared to group II ($p<0.05$) (Figure 2).

In group I, the peak left shoulder external rotator torques were higher and acceleration times were shorter compared to group II ($p<0.05$) (Figure 3).

No statistically significant differences were observed in deficit and endurance ratios between the two groups ($p>0.05$) (Figures 4 and 5).

When we compared the WANT results, it was found that the peak power, mean power, minimum power, fatigue index, peak-time and low-time values were similar in both groups ($p>0.05$) (Figure 6).

Table 1. Physical characteristics of the players.

	group I (n=14)		group II (n=14)	
	Mean	SD	Mean	SD
Age (years)	26.10	2.70	19.4	1.90*
Height (cm)	173.40	12.50	173.2	11.70
Body weight (kg)	68.50	12.60	58.40	6.90*
Disability age (years)	16.21	7.32	19.85	6.12
Years of sports experience	8.46	3.4	3.77	1.79*

*p<0.05
Group I: young national wheelchair basketball players,
Group II: national junior wheelchair basketball players.

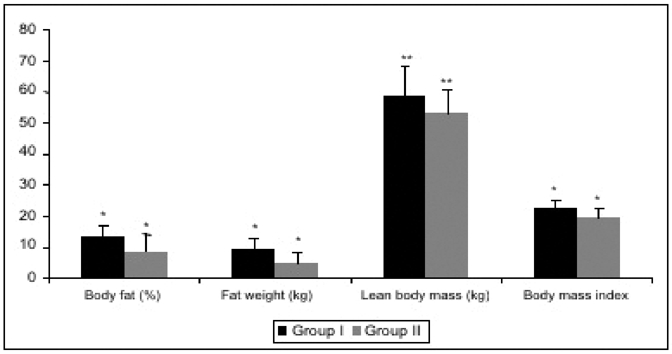

Figure 1. Percentages of body fat, fat weight, lean body mass and BMI (*p<0.05, **p>0.05, Mann-Whitney U test).

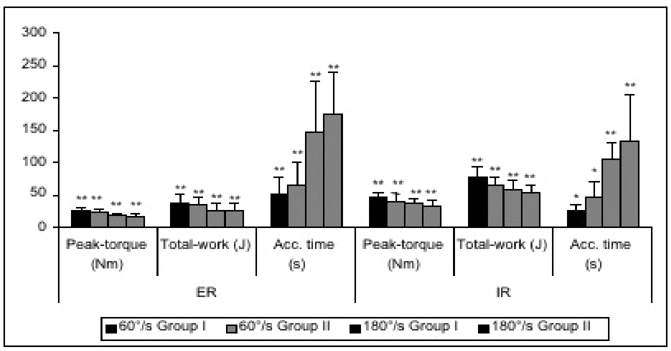

Figure 2. Peak right shoulder torques, total work values, and acceleration times (*p<0.05, **p>0.05, Mann-Whitney U test. ER: External Rotation, IR: Internal Rotation, Acc. time: Acceleration Time).

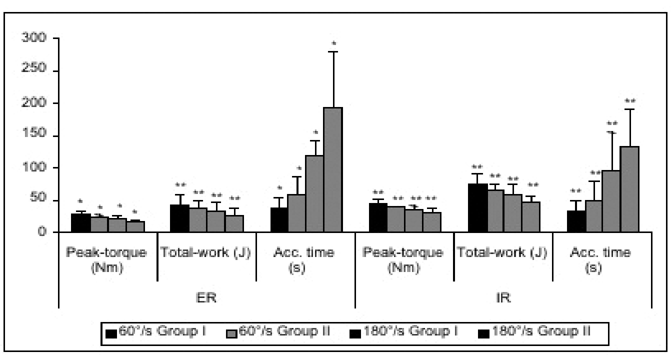

Figure 3. Peak left shoulder torques, total work values, and acceleration times (*p<0.05, **p>0.05, Mann-Whitney U test. ER: External Rotation, IR: Internal Rotation, Acc. time :Acceleration Time).

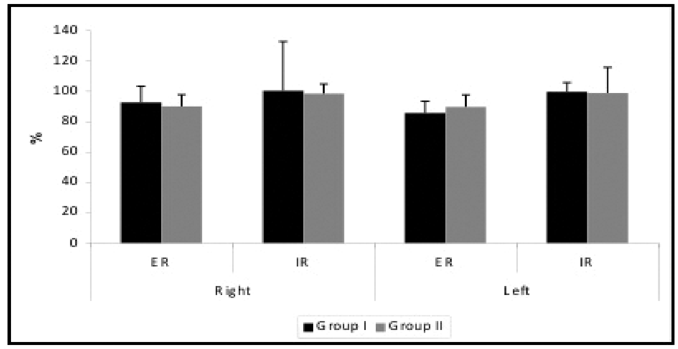

Figure 4. Endurance ratios of the players (p>0.05, Mann-Whitney U test. ER: External Rotation, IR: Internal Rotation).

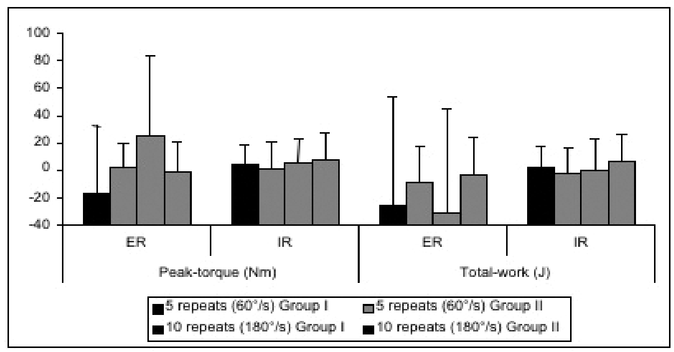

Figure 5. Deficit ratios of the players (p>0.05, Mann-Whitney U test. ER: External Rotation, IR: Internal Rotation).

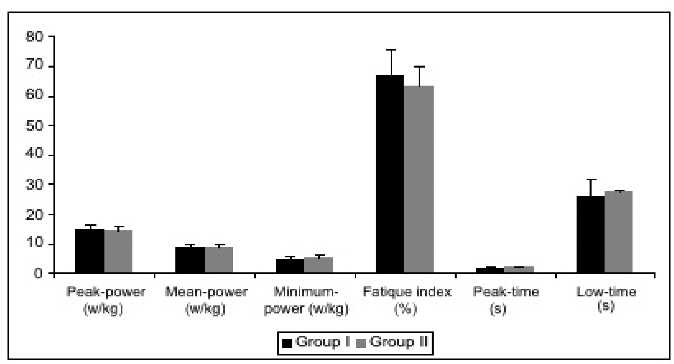

Figure 6. Peak-power, mean-power, minimum-power, fatique index, peak-time and low-time values of the WANT (p>0.05, Mann-Whitney U test).

Discussion

This study compared the body composition, anaerobic power and isokinetic muscle strength of the shoulder rotators of young national and national junior wheelchair basketball players.

When we assessed the percentage of body fat, fat weight, and body weight without fat, we found different values. Since we compared two different age groups, these findings might be accepted as natural. The lean body mass values were the same in the two groups. These results are very important because muscle strength is known to be related to lean body mass.

The endurance and strength of certain muscle groups were evaluated by isokinetic strength tests. The peak left shoulder external rotation torque values at 60 and 180°/s were significantly elevated in group I. The left side was not dominant in either group. The literature provides limited data on this subject. Bernard et al. (19) assessed the influence of propulsion and the level of injury on isokinetic shoulder rotational strength. The authors observed increased peak power and mean external rotator power on the non-dominant side in mild and severely paraplegic individuals. In addition, they found that the external rotators on the non-dominant side have greater peak power and mean power than the internal rotators. They tested the shoulder joint rotation of class 1, 2 and 3 basketball players at speeds of 60°/s and 80°/s and observed that the ratios on the dominant side were elevated with respect to the non-dominant side (20). The authors did not observe any significant differences in the peak torque values across the groups. However, the non-dominant/dominant external rotation torque ratios were significantly different in class 1. In addition, the class 1 values were significantly lower than those of the other classes. They concluded that individuals in class 1 were substantially more dependent on wheelchairs than other individuals.

Players use their external rotators when pushing their wheelchairs forward. During wheelchair basketball training, propulsion is the principal and longest-lasting activity (compared to pushing back).

We believe that this difference originates from the muscle kinetics of wheelchair propulsion. Wheelchair propulsion involves two phases: propulsion and recovery. It has been proposed that, after many years of propulsion, the muscles that are active during the push phase become stronger. However, the muscles that are used for recovery remain at the same strength (1). An internal rotation moment has been observed during the push phase of the propulsion cycle, which would indicate a need for external rotator muscle activity. This was confirmed by the presence of electromyographic (EMG) activity of the infraspinatus and the absence of EMG activity of the subscapularis during wheelchair propulsion (21). It has been proposed that these muscle groups become stronger during long-term wheelchair propulsion. Selective muscle strengthening and endurance training are crucial for obtaining and maintaining optimum shoulder function in wheelchair basketball athletes.

Based on the isokinetic test results, the peak torque, total work and acceleration time values were significantly greater in group I for the acceleration time of right shoulder internal rotation at a speed of 60°/s . This was also the case for the peak torque and acceleration time of left shoulder external rotation at speeds of 60°/s and 180°/s. These findings indicate that peak torques and acceleration times in the young national team were superior to those of the national junior team. We suggest that these differences in acceleration time and peak torque originated from sport-specific skills and differences in the training habits of the players. No differences in the deficit and endurance ratios were observed. To the best of our knowledge, a study similar to ours that compares the deficit and endurance ratios of wheelchair players at various ages is not present in the literature.

In recent years, anaerobic exercise tests have been developed to estimate metabolic energy capacity during short-term exercise (7,22). There are special test protocols that measure anaerobic capacities of players to assess their accelerated performances. WANT has been performed on able-bodied athletes for many years. This protocol is a good assessment method, particularly for individuals with lower-extremity injuries (22).

Since the athletes in group I had many years of sports experience, it might be expected that their WANT results (especially peak power and mean power) would be significantly elevated. However, we observed no significant differences in WANT parameters between the two groups. The limited number of players in each group may have contributed to this result. Different data may be obtained from groups with different ages.

Veeger et al. (15) studied anaerobic power of wheelchair-dependent individuals. The authors classified the individuals according to their lesion levels and studied their anaerobic power using the 30 s acceleration test and a wheelchair ergometer. They observed no significant differences between the groups. This is similar to our results.

This study investigated the different isokinetic muscle strengths and anaerobic power values in the young national and national junior wheelchair basketball players. In wheelchair basketball players, the classification criteria and correlation between the test power and power parameters of the wheelchair treadmill, wheelchair and ergometer during short-term exercise require further study. We believe that because there is no previous research on this subject, this study will enrich the literature by leading the way for other studies.

Conflict of Interest

Authors reported no conflicts of interest.

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