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# Teaching of new sport skill to weightlifters: problem in performance and motor learning

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## ABSTRACT

Kordi, H., Mohamadi, J. & Ghotbi, M. (2013). Opinions about judo athletes' image. *J. Hum. Sport Exerc., 8*(4), pp.996-1007. This study would report about one of the problems (learning of a new sport skill) that occurs probably following weightlifting and decrease range of motion (ROM). Weightlifters (WLs) group (n=20) and Non-Weightlifters (NWs) group (n=20) were trained overhand serve volleyball based on a similar schedule program. The Results of performance accuracy showed, WLs didn't learn the skill, but NWs learned did. When ROM had been controlled, performance of WLs and NWs were not different. We observed, WLs had noticeable differences in pattern of joints displacement in comparison with NWs and reference pattern of serve skill. Thus, it seems that WLs encounter with some problems regarding performance and learning of new motor skills due to ROM's limitation. **Key words**: MOTOR LEARNING, MOTOR PERFORMANCE, DECREASE RANGE OF MOTION, WEIGHT LIFTING.

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## INTRODUCTION

Background on benefits and damages caused by strength training and weightlifting dates back to many years ago (Chiu & Schilling, 2005). Some researches believed that strength training is related to motor learning, because athletes learns how produce pattern of muscle requirement for optimum performance (Carroll et al., 2001). Also Haff & Potteiger (2001) announced weightlifting could lead to improvement of sport performance via neuromuscular adaptations. Because of joints and muscle's involvements while weightlifting the whole inside-outside muscular synchronization need to be adjusted which it consequently result in efficacy and balance of muscles (Canavan et al., 1996; Haff & Potteiger, 2001; Newton & Kraemer, 1994). According to Fry et al. (2003) weightlifting improves the motor control similar to sports which have technical features. Therefore, strength training lead to increase muscle synchronization (Carroll et al., 2001). But generally speaking, transfer of weightlifting benefits is strangest in movements which force generating, power and strength play a basic role (e.g., jumping) and weakest in sports with less biomechanical aspects, for example open water swimming, comparing weightlifting movements (Hedrick, & Wada, 2008).

Other related studies showed that weight lifters would be interested in hypertrophy through training qualities and needing to obtain more muscle's strength and power (Barlow et al., 2002; Kanehisa et al., 2005). Whereas hypertrophy would lead to limited range of motion in overall movement's shoulder joint of weightlifters (Carroll et al., 2001; Kolber et al., 2009; Kolber & Corrao, 2011). Flexibility or ROM means joint ability in performing the actions before the movement is limited by skeleton system, ligaments or the volume of the muscles around the joint (American College of Sports Medicine [ACSM], 2005), it is considered as an important factor in evaluation of physical fitness in people (Hands, 2008). Previous researches' recognized the relationship among physical fitness, motor performance and motor ability (Haga, 2009; Hands, & Larkin, 2006) because there have been observed people who had lack of flexibility, had worse performance and suffered from many problems in performing motor skills such as overhand throwing and vertical Jumping (Hands, 2008). It is suggested that Learning disability is highly predictive of restriction of mobility (Beckung & Hagberg, 2002; Chan et al., 2005). Furthermore, Beckung & Hagberg (2002) pointed out that Learning disability, activity limitations and participate restrictions were all clinically strongly associated with each other ($p<0.001$). Hammond (1995), O'Beirne & Larkin (1991) observed that children, who had problem in motor learning, suffered from ROM disorders such as hypo-hyper flexible (Hands, 2008). Another survey Hands, & Larkin (2006) reported that children with the age of 5 to 8, who had some problems in motor learning, had less flexibility than control group. These results had also been observed in older samples (Cantell et al., 2008).

Learning development is one of the most important aims in physical education. Although weight training is done to increases strength, power and decreases injury prevalence by many athletes (Starkey et al., 1996) it must be noticed that limitation in ROM is one of its side effects (Barlow et al., 2002; Corrao et al., 2009; Kolber et al., 2009; Kolber & Corrao, 2011). Since decrease in ROM would result in changing biomechanical patterns, decreasing the efficiency of force production, increasing the musculoskeletal system injuries (Daneshmandi et al., 2010) and Faulty Posture (Chandler et al., 1990), therefore, decrease in optimum arm momentum could be predicted following biomechanical disability (Wilk et al., 1997). It is noteworthy that what has not been paid attention properly is that athletes in this sport after years of exercising achieve particular features like high strength and power or less ROM which stay with them along their lifetime. Since many of young weightlifters are exposed to learning of other sport skills in daily life, job or study situation (like physical education students), therefore, in this research we surveyed quality of a new sport skill in weightlifters to answer the following question.

 

Do physical side effects of weightlifting, result in progress or limitation for learning process of a new sport skill?

So, we taught overhand serve volleyball to weightlifters and control group (non-weightlifters) with a similar schedule program (3 sessions, 120 trials) and compared their performance with reference group (elite volleyball players).

## METHODOLOGY

### *Participants*

There were 40 male participants, 20-25 years of age that lived in Tehran, there were 20 weightlifters (WL) aged 21.51±1.34 distributed to experimental group (EG) and 20 non weightlifters (NW) aged 21.32±1.21 to control group (CG). Besides, three elite volleyball players (VP) aged 20.41±1.23 were employed just to make the reference pattern of serve skill. In this study EG were Weight lifters who have been training 3 days a week for the past 3 years (Barlow et al., 2002) and non-weightlifters were people who haven't had any weight training experiences in their life. All of the participants were right handed and didn't have any symptoms of muscuskeletal pain and injury. The samples participated voluntary and were novice performers in volleyball serve. This study was approved by the ethical committee of Arak University of Medical Sciences.

### *Materials*

Edinburgh Handedness Inventory was used to detect the dominant hands of participates and Nordic Muscuskeletal injury Questionnaire to make sure of participant's health. Besides, we used standard universal Goniometer (with 0.1 degree accuracy) to measure the shoulder ROM. Validity and Reliability of Nordic Muscuskeletal injury Questionnaire (Kuorinka et al., 1987), Edinburgh Handedness Inventory (Williams, 1991) and Universal Goniometer for assessment of ROM (Kaplan et al., 2011) had been proved previously.

Participants' learning was evaluated by assessment of performance accuracy and kinematical analysis. We used American Alliance for Health Physical Education, Recreation, and Dance (AHPPERD) overhand volleyball serve test (1969) to measure the performance accuracy of the samples. This test is one of the prevalent methods for evaluation of volleyball serve; in which the samples have to perform 10 efforts (French et al., 1991). Moreover, kinematical aspects of performance recorded in side position with a video camera (250 Hz, 1.2000 s) in two dimensions for all of the participants. According to Fleisig et al. (2006) reflective markers were set on lateral superior tip of the acromion, lateral humeral epicondyle, ulnar and radial styloid, distal end of the 3rd metacarpal.

### *Teaching plan and tests of learning*

Having attended to weightlifting club of Tehran and distributing Questionnaires, researcher evaluated information of all WLs. Researchers invited WLs who didn't have any injury during the previous week at the time and didn't have any experience in volleyball training and have been right handed to participate in this study. Also NWs were selected from no physical education students of Tehran Azad University by the same procedure.

Samples were explained as to the aim of the study and quality performance of serve skill. According to Schmidt's method (1991) pre-practice considerations were taken into practice (Schmidt, 1991). Then pre-test was taken by two groups. In which accuracy of performance evaluated with AHPPERD test and were recorded from three preliminary of participant's trials. Besides, performance of VPs was recorded (each person three trials) to make the reference pattern of serve skill.

Then participations practiced overhand serve for three sections in one week with 120 trials, therefore, they performed 40 trials every day (4 blocks in 10 trials). All of the practice trials were performed from right side of volleyball playground. We gave Summary feedback along acquisition phases about the knowledge of performance (KR) like Weeks, & Sherwood (1994) with regularly one KR to five trials. Acquisition tests were taken without feedback at the end of every acquisition phases. Practice sessions of two groups were administered separately, with the same educator and plane design. Retention test was performed after 24 hour from the last acquisition test and transfer test was taken at the left side of volleyball playground. Figure 1 shows the process of this study.

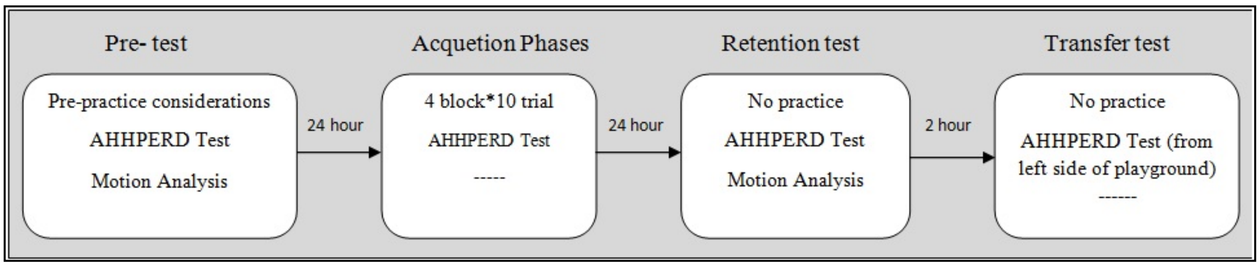


***Figure 1.*** *The process of practice and tests plan of this study*

*Range of motion assessment*
According to Norkin & White (1995) method, we measured ROM of internal rotation (IR), external rotation (ER) and abduction of shoulder joint. All measures were taken after fifteen minute warm up in the morning. To measure IR and ER of the shoulder, the arm was positioned in 90° and the elbow was in flexion of 90°, while the subjects were lying supine. Then participants were required to conduct the rotation up to the end of ROM. After that, the rotation was recorded. To measure ROM of abduction, the angle between the arm bone and trunk was recorded with the participants lying prone on bed and abducting the arm from one side of the body (Barlow et al., 2002). In this study, overall shoulder range of motion evaluated through adding IR, ER and abduction (Tovin & Greenfield, 2001).

*Statistical Analysis*
Data normality was tested with Kolmogorov-Smirnov primary, and then ROM of WLs and NWs was compared. Also, Analysis of Variance with repeated measures was used to compare inside and outside groups from pre test to transfer test.

The pictures of participator's performance were analyzed using motion analysis soft ware, then the data processed by Winanalyze2 version 4. Finally, motion analysis data were calculated through Execle soft ware to draw joint displacement graphs. Besides, kinematical data were analyzed through SPSS soft ware using independent t-test, Covariance Analysis and Pierson correlation coefficient.

2 - Mikromark Company (1998)

 

## RESULT

*Shoulder Range of motion*

Comparing the ROM of WLs and NWs revealed that ROM of WLs in IR (t (38) =4.658; P<0.001), ER (t (38) =6.026; P<0.0001), and abduction (t (38) =6.453; P<0.0001) was less than NWs.

*Accuracy of performance*

The comparison of mean score performance of WLs and NWs in pre-test indicated that there were not significant differences (t (38) =1.526; P=0.135) between groups in accuracy of overhand volleyball serve performance. Repeated measure test [2 groups' × 6 tests] was used to calculate the variation of the performance from pre-test to transfer test (table 1). Data analysis showed that performance of two groups (WLs & NWs) changed significantly (F (5, 95) =25.322; P<0.0001), therefore, practice had affected the performance accuracy of volleyball serve. But the performance of two groups had significant differences along the study (F (1, 19) =20.283; P<0.0 001). It means performance of two groups was improved differently from pre-test to transfer test.

***Table 1**. Comparison of performance for two groups from pre-test to transfer test*

| Source | Type III Sum of Squares | Mean Square | F | P | Partial Eta Squared |
|---|---|---|---|---|---|
| **Test's** | 2509.37 | 501.874 | 25.322 | 0.0001 | 0.571 |
| **Groups** | 80.50 | 80.50 | 20.283 | 0.0001 | 0.516 |
| **Test's * Groups** | 514.67 | 102.93 | 29.285 | 0.0001 | 0.607 |

*Figure 2 demonstrates diversity of the performance accuracy of serve skill between WLs and CG. This graph shows performance improvement process of weightlifters group and control group.*

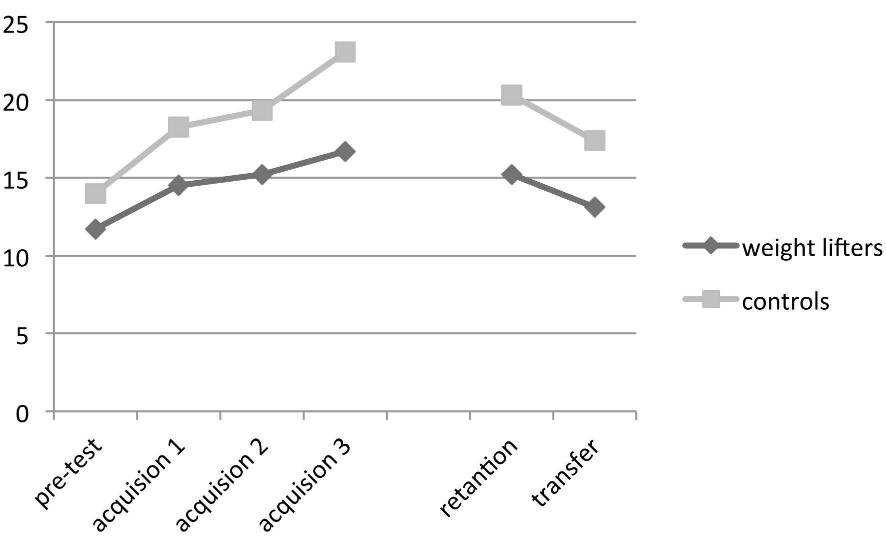


***Figure 2.** Performance graphs of two groups from pre-test to transfer test*

Table 2 shows the results of dependent t-test for two groups. WLs performance didn't have significant differences from pre-test to retention test (t (20) = -1.84; P=0.081) and pre-test to transfer test (t (20) =1.99; P=0.061). But CG had significant differences from pre-test to retention (t (20) = -4.62; P<0.0001) and to transfer test (t (20) = -2.39; P=0.027). Therefore, WLs performance did not demonstrate the learning of the skill which they practiced.

***Table 2**. Inside groups comparison of mean score from pre-test to transfer test*

| Group | Paired Between | Paired Differences | | | T | P |
|---|---|---|---|---|---|---|
| | | Mean | Std. Deviation | Std. Error Mean | | |
| **Weight lifters** | Pre-test & Retention test | -1.00 | 2.428 | 0.543 | -1.842 | 0.081 |
| | Pre-test & Transfer test | 1.35 | 3.031 | 0.678 | 1.992 | 0.061 |
| **Control** | Pre-test & Retention test | -6.30 | 6.088 | 1.361 | -4.628 | 0.0001 |
| | Pre-test & Transfer test | -3.10 | 5.794 | 1.296 | -2.393 | 0.027 |

Moreover, covariance analysis controlling the shoulder overall ROM showed that there were no significant differences (F (1, 37) = 2.85; P=0.10) but there were significant differences in retention test (F (1, 37) =22.43; P<0.0001) and transfer test (F (1, 37) =21.35; P<0.0001) between WLs and NWs in pre-test. Therefore, performance accuracy of two groups was different from each other, even when the effect of ROM factor was controlled.

*Kinematical aspect of performance*

Six kinematic variables including liner displacement of shoulder joint, liner displacement of elbow joint, liner displacement of wrist joint, liner velocity of shoulder, liner velocity of elbow, liner velocity of the wrist joints were studied. Outcomes of Wilks' Lambda test showed, kinematic qualities of serve performance between WLs and NWs in pre-test were significantly different (F (1, 9) =7.856; P=0.033, partial $\eta 2$=0.922). But the results of covariance analysis controlling the ROM factor, demonstrated no significant differences (p<0.05) between WLs NWs for all of the kinematical variables in pre-test (table 3).

 

***Table 3.*** *Compare performance kinematical variables of two groups from pre-test to retention test*

| | Dependent Variable | Type III Sum of Squares | Mean Square | F | Sig | Partial $\eta^2$ |
|---|---|---|---|---|---|---|
| **Pre-test** | Displacement of Elbow | 0.190 | 0.190 | 1.285 | 0.286 | 0.125 |
| | Velocity of Elbow | 0.043 | 0.043 | 1.162 | 0.309 | 0.114 |
| | Displacement of Wrist | 0.177 | 0.177 | 2.650 | 0.138 | 0.227 |
| | Velocity of Wrist | 0.029 | 0.029 | 0.253 | 0.627 | 0.027 |
| | Displacement of Shoulder | 0.209 | 0.209 | 1.191 | 0.303 | 0.117 |
| | Velocity of Shoulder | 0.066 | 0.066 | 2.152 | 0.176 | 0.193 |
| **Retention test** | Displacement of Elbow | 0.021 | 0.021 | 0.107 | 0.751 | 0.012 |
| | Velocity of Elbow | 0.000 | 0.0001 | 0.002 | 0.968 | 0.000 |
| | Displacement of Wrist | 0.014 | 0.014 | 0.097 | 0.763 | 0.011 |
| | Velocity of Wrist | 0.000 | 0.0001 | 0.001 | 0.977 | 0.0001 |
| | Displacement of Shoulder | 0.045 | 0.045 | 0.185 | 0.678 | 0.020 |
| | Velocity of Shoulder | 0.025 | 0.025 | 0.322 | 0.584 | 0.035 |

But, Wilks' Lambda test outcomes showed performance kinematical qualities didn't have differences significant ($F (1, 9) = 0.316$; $P=0.899$, partial $\eta2=0.322$) between WLs and NWs in retention test. Besides, comparison of six kinematical variables demonstrated no significant differences ($P<0.05$) between WLs and NWs in retention test (table 3). Therefore, we can say when the effect of ROM factor was controlled, the performance's kinematics of WLs had significant differences with performance's kinematics of NWs neither in pre-test nor retention test.

Then, the liner displacement of shoulder, elbow and wrist joint's graphs were drowned to compare the performance quality of participations. One person randomly from each group was selected to compare liner displacement of joint's graphs in pre-test and retention test (figure 3), though, the other members in each group had similar displacement joints pattern relatively. Figure 3 shows that the joints displacement patterns of WL (3.b) were different obviously from the joint displacement pattern of NW (3.c) and VP (3.a) in pre-test.

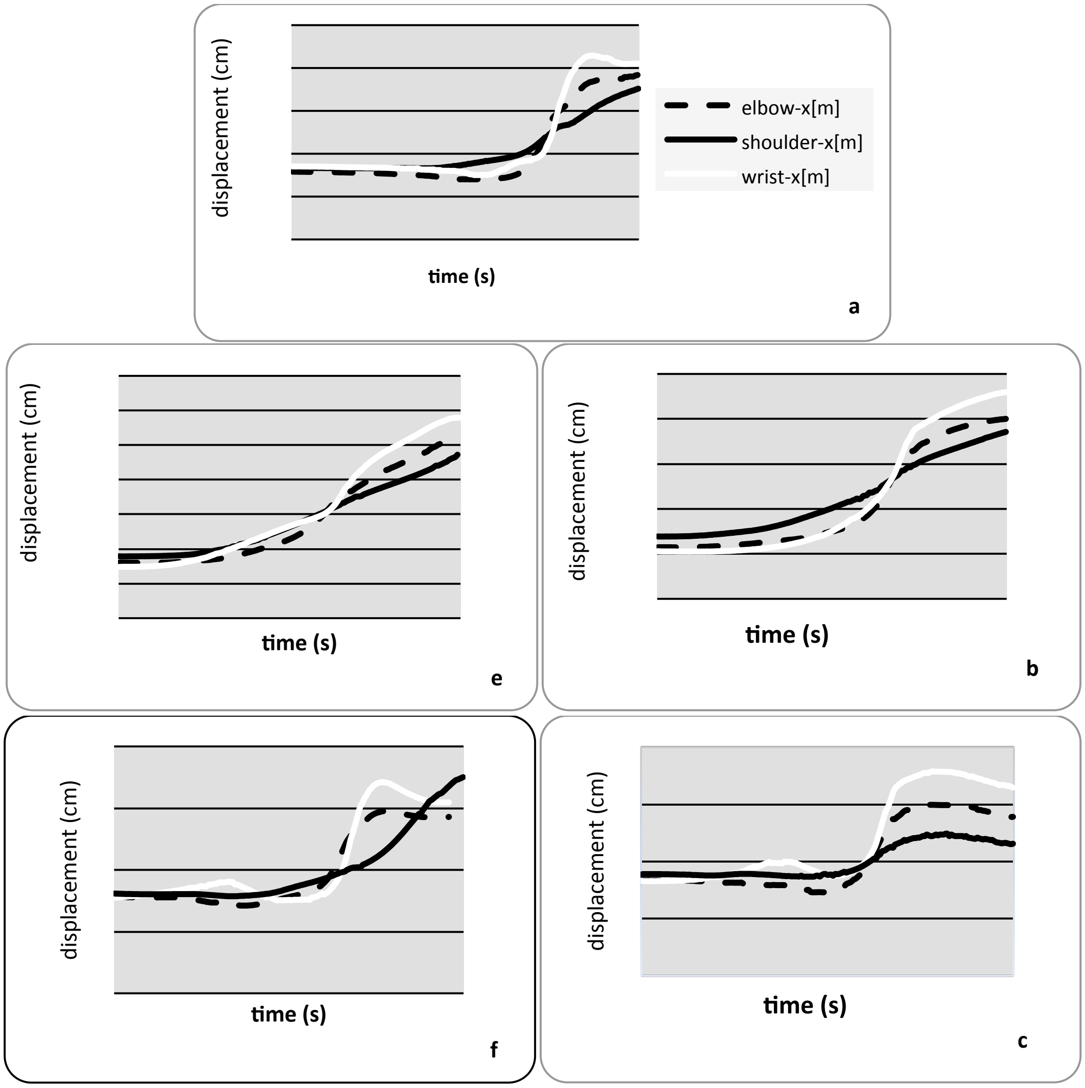


***Figure 3.*** *Liner displacement of shoulder, elbow and wrist joints graph's one of member each group; elite volleyball player (E1) from reference group (a), weightlifter (W5) from experimental group in pre test (b) and retention test (e), non weightlifter (N8) from control group in pre test (c) and post test (f)*

Furthermore, joints displacement graph of WL (3.e) was different obviously from the joints displacement graph of NW (3.f) and VP (3.a) in retention test. Therefore, motion displacement patterns of shoulder, elbow and wrist WL's joints were different from volleyball player and non-weightlifter both in pre-test and retention test. Nevertheless, it seems that joints displacement pattern of NWs (3.c & 3.f) is more similar to that of VPs (3.a).

## DISCUSSION

Researchers intended to quality process of performance and learning of a new sport skill (overhand serve) observed in WLs who had range of motion limitation. Therefore, we tried to control other variables that affect the motor learning procedure. Gender (Dorfberger et al., 2009) and age (Perrot & Bertsch, 2007) is suggested to affect motor learning. Consequently, we selected purposefully all of the participants among male participants who hadn't significant differences (P=0.732) in the mean age to eliminate the effect of gender and age. Besides, participations (EG and CG) didn't have any significant differences (P=0.135) in performance accuracy of serve skill on pre-test. Therefore, the researchers employed only those who had differences in weight training experience and ROM characteristic. So we intended to examine the hypothesis that decrease ROM as a result of long term weight training might lead WLs to some problems for learning of a new motor skill.

The Results demonstrated that WLs had shoulder ROM less than NWs (p<0.05). This result was in the line with previous studies which administered on weight trainers (Barlow et al., 2002; Calhoon & Fry, 1999; Kolber et al., 2009; Kolber & Corrao, 2011). In previous studies, hypertrophy (Barlow et al., 2002; Calhoon, & Fry, 1999), Posterior shoulder tightness (Kolber et al., 2009; Kolber & Corrao, 2011), negative musculoskeletal adaptation or maladaptation through repeated motions under specific ROM (Daneshmandi et al., 2010), unfavorable positions of shoulder during weight lifting with heavy loads and training for a long time (Corrao et al., 2009 Kolber et al., 2009; Kolber & Corrao, 2011) were mentioned as the important reasons of ROM decrease in WLs.

When analysis was performed based on accuracy performance of participates, it was observed that performance of two groups (WLs & NWs) was developed significantly (F=6.77; P=0.022), but performance of WLs & NWs was different from each other along the process of practicing (Table 1). Then, inside group's comparison showed that WLs performance in retention and transfer test was not better than pre-test, but performance of NWs in retention and transfer tests were better than pre-test (Table 2). Scores comparing of performance accuracy showed, between WLs & NWs there was not significant differences even by controlling the ROM effect. Meanwhile, performance graph of two groups (WLs & NWs) demonstrated there were evident differences along the process of study from pre-test to transfer test (Figure 2). Generally, results of comparing the performance accuracy of WLs and NWs showed, WL's performance diversity revealed not pointing of learning, but the results demonstrated that NWs learned serve skill.

Then kinematical data was compared between WLs & NWs for more precise analogy. The results demonstrated that controlling ROM variable kinematics of these two group's performance were not significantly different (P<0.05) in pre-test and retention test (Table 3). Then to analysis the performance quality of participants, WL's & NW's joints displacement's graphs were drowned to be compared with the reference pattern (elite volleyball players). In those graphs it was showed that the WL's joints displacements patterns (Figure 3.b) were considerably different from NW (Figure 3.c) and VP (Figure 3.a) in pre-test up to retention test. While NW's joint displacement pattern (Figure 3.f) was more similar to VP pattern (Figure 3.a).therefore, it can be inferred that WL's range of motion limitation made a notable difference in their joint displacement pattern. That is, the observed differences in retention test could be as a result of the differences from the pre-test. In fact, ROM limitation could be regarded as one of the factor that affected the failure in overhand serve performance which is in the line with the previous researches. For example, Hands (2008) reported, people with low flexibility had weaker performances in overhead throwing skills. It was also reported that there was a strong correlation between ROM and hand performance (Bland et al., 2008; Cooper et al., 1993). Consequently limiting shoulder ROM would lead to decrease in hand performance of the young healthy participants (Bland et al., 2008). Beckung & Hagberg (2002) reported that there is a relation between learning disabilities and movement limitation and decrease in ROM affect the performance of gross and fine movement skills. O'Beirne & Larkin (1991), and Hammond (1995) also observed that children with motor learning difficulties have less flexibility than control group

(Hands, 2008). So this finding is in the line with Rosenbaum's idea (2007) which announced, motor limitations cause limitation in development of perception experience and decline motor learning in people.

Since weight training programs which are based on specific muscle groups generally ignore the necessary strength balance and mobility for suitable performance of shoulder (Kolber et al., 2009). Therefore it was not unlikely that WLs would have difficulty in performing and learning of over hand serve in which shoulder plays an important role. Due to the fact that natural performance of shoulder requires a fine synchronization between strength and mobility of involved muscles in that skill (Kolber & Corrao, 2011). Furthermore, the results of this study is in the line with Hedric & Wada's ideas (2008) which stated, movements with less biomechanical similarity to weightlifting do not benefit from weight lifting exercises extremely.

## CONCLUSION

It was seen that WLs encounter some problems in learning and performing new sport skill. In this study we can just conclude that this problem might be due to weightlifter's ROM limitation, on the other hand it is not possible to mention explicitly that WLs have problems in motor learning because of the fact that from the very beginning (from pre-test) they could not perform the skill qualitatively similar to NWs. This difference was seen along the whole procedure in a way the WLs could not approach the reference kinematical pattern (VPs) but NWs could considerably modify their own motor pattern with the same practice and approach the reference pattern. Therefore, probably the observed differences in retention phase are due to preliminary differences between two groups. Finally, it is recommended to point out that weightlifters face some problems as a result of ROM limitation in performing of serve skill and postpone an absolute judgment regarding learning disabilities to further researches in the future.

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