Average power and average peak torque of trunk extensors isokinetic outputs did not vary with the change of the scapular positions among healthy subjects

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ABSTRACT

Background: Maintaining good strength at trunk muscles extensors plays a vital role in enjoying good physical health.

Purpose: The main aim of this study was to examine the effect of assuming different scapular positions on the isokinetic output of the trunk extensors.

Method and Materials: Twenty six healthy college students were recruited to participate. The researcher collected demographic data in addition to recording full spinal mobility. Every participant was instructed to extend his trunk against the Biodex machine that was set at a velocity of 60° per second. Every participant has to assume the position of scapular protraction, retraction and depression via changing the elbows positions while having the fingers interlaced. The researcher measured the average peak torque and the average power in addition to all other available outputs.

Results: A one-way MANOVA was calculated examining the effect of changing scapular positions on average power and average peak torque. No significant effect was found \( \Lambda (2,24) = 1.09, p > 0.05 \) for average power. No significant effect was also found \( \Lambda (2,24) = 0.60, p > 0.05 \) for average peak torque.

Conclusion: No significant difference was detected while assuming different scapular positions and having participants doing back extension at 60° per second. However, from clinical perspective, clinicians should consider the level of difficulties experienced by subjects in designing a viable gradual resistive exercise program.

Key words: Isokinetic testing, peak torque, average power, back extensors.
INTRODUCTION
Trunk extensors strength is essential for the health of the trunk muscles. Several researchers have used different methods for examining trunk muscles strength and endurance. Dr. El-gohary has recently published a series of research papers regarding the performance of the trunk extensors among healthy subjects. Dr. El-gohary and others studied also patients with low back pain. There is more fatigue in extensors compared with the flexors of the trunk. Olson conducted a study to identify the levels of muscle activation necessary to main certain levels of force output. Trunk muscle extensors were the focus of study using isokinetic dynamometer to determine muscle activation during sub-maximal isometric trunk extension efforts. Mayer et al. used sagittal isokinetic movement to assure reliability of strength testing among normal subjects. Isokinetic testing of the trunk extensors has shown good reliability among healthy subjects tested at 60° per second. Karatas et al. have considered the peak torque of the trunk extensors at different angular velocities among patients and healthy controls. Test posture is considered fundamental to influence test outputs. Shirado et al. emphasized on having researchers to carefully consider the test posture when measuring the strength of the trunk muscles. However, there is a gap in the body of knowledge regarding the effect of changing the position of the scapulae on the isokinetic output during testing the extensor muscles of the back. The aim of the study was to examine the effect of changing the scapular positions on the average power and average peak torque of the back extensors isokinetic outputs. It has been hypothesized that the changes of the scapular positions would not affect the average power or the average peak torque of the isokinetic output obtained from back extension at 60° per second.

METHODS AND MATERIALS
Subjects
Twenty six consecutive healthy physical therapy male students, aged between 20 and 24 years, were recruited from college of medical rehabilitation sciences, Taibah University in Al-Madina Al-Munawara city. Participants demographics are included in table one. The study design is a repeated- measure design. Inclusion criteria: subjects were included if they were healthy and enjoy good spinal, upper limbs, and lower limbs mobility. Exclusion criteria: subjects were excluded if they had any spinal surgery, significant pain or active health problem.

Procedure
The researchers started off by explaining the study protocol to participants. Subjects had to sign a written informed consent. The study protocol was approved by institutional review board of college of medical rehabilitation sciences (CMR-PT-2018-05). First, the researcher measured forward, backward, right side and left side spinal mobility. Second, the researcher measured the trunk extension at 60° per second while having the scapulae at three different positions. The elbows were set at forward, lateral and downward positions as shown on (figure 1). Participants were instructed to interlace fingers behind head and adduct both arms to have both elbows pointing forward. Also, participants had to abduct both arms to have both elbows pointing lateral. Regarding downward elbows position, participants were instructed to put hands on chest. The angular velocity was set at 60° per second. The tester made sure that every participant is in comfortable sitting position and secured. Every participant has to practice a trial session to familiarize with the maneuver. After taking ten minutes rest, every participant has to execute a 10 minute single- session protocol. The protocol consisted of performing three trials of three maximum flexion- extension concentric exertion at 60°/second with the range of trunk motion= 50°. The researcher has counterbalanced the order of measurements.
Figure 1. Participant is doing back extension using Biodex isokinetic system at three Scapular protraction (a), retraction (b) and depression (c) positions.

Statistical Analysis

Descriptive statistics was obtained for all study variables (Table 1). The Mauchly’s test of sphericity was run to test for homogeneity of variances of pairwise differences between levels of within-subjects factors. A multivariate analysis of variance (MANOVA) was conducted to check for any significance difference within the repeated measures achieved from the Isokinetic outputs obtained from three different scapular positions. The MANOVA was chosen to confirm the results since the average power and the average peak torque are related outputs.\textsuperscript{11,12} SPSS 22 was the software used for all data analysis. (SPSS Inc. Headquarter, 233 S. Wacker Drive, Chicago, Illinois 60606, USA).

RESULTS

The Mauchly’s test of sphericity gave a $P$ value which was more than 0.05; therefore we can assume that the assumption of sphericity is met. A one-way MANOVA was calculated examining the effect of changing scapular positions on average power and average peak torque of Isokinetic testing of trunk extension at 60° per second. No significant effect was found [$\Lambda(2,24) = 1.09, p > 0.05$] for average power (Figure 2). Also, no significant effect was found [$\Lambda(2,24) = 0.60, p > 0.05$] for average peak torque (Figure 3).
Table I: Descriptive statistics of demographics and isokinetic output at three scapular positions.

|        | N | Minimum | Maximum | Mean   | SD  |
|--------|---|---------|---------|--------|-----|
| Age    | 26| 20      | 24      | 22.1   | 1.03|
| Height | 26| 1.60    | 1.85    | 1.71   | 0.07|
| Weight | 26| 47      | 110     | 69.9   | 15.6|
| BMI    | 26| 17.5    | 39.4    | 24.04  | 5.2 |
| Scap_PAP| 26| 34      | 240     | 96.6   | 42.9|
| Scap_RAP| 26| 34      | 211     | 94.9   | 39.2|
| Scap_DAP| 26| 27      | 227     | 101.3  | 45.3|
| Scap_PAPT| 26| 67      | 342     | 154.7  | 63.6|
| Scap_RAPT| 26| 78      | 354     | 148.9  | 62.6|
| Scap_DAPT| 26| 50      | 318     | 151.5  | 60.6|

Scap_PAP: scapular protraction average power, RAP: retraction average power, DAP: depression average power, PAPT: protraction average peak torque, RAPT: retraction average peak torque, DAPT: depression average peak torque, SD: standard deviation.

Figure 2: Bar charts of the mean values± SD of the average power obtained at scapular protraction, retraction and depression.
DISCUSSION

The study findings did not show any significant difference within the repeated measurements obtained from doing back extension at 60° per second while having the scapulae at protraction, retraction and depression positions. The current study coincides with the study carried out by Keller et al. in terms of the chosen angular velocity, study subjects and measurement outcomes of the designated trunk muscles. Keller et al. conducted reliability study to determine the reproducibility of the isokinetic trunk extensor strength among healthy individuals. Measurements were performed by the same experienced tester and the angular velocity was set at 60° per second. Symons et al. reported good test-retest reliability for a single-session isokinetic strength testing. The study carried out by Shirado et al. was in harmony with the current study regarding the test posture effect on trunk extensors. Shirado et al. conducted a study on healthy subjects and group of patients to determine the influence of test posture on strength of trunk muscles. The peak torque was the main outcome measure. The findings of the study showed that muscle imbalance...
and test posture are the main determinants and trunk extensors are more affected than trunk flexors. Moreover, the trunk extensors were the main focus of several research works with the objectives of studying the motor control and level of activation. Ripamonti et al. pointed out the importance of torque-velocity and power-velocity relationships during any rehabilitation program. They have added that strength training of trunk extensors should be the focus of any rehabilitation program. Olson reported that the neuromuscular system modulates its motor control strategy to identify the muscle activation levels necessary to maintain force output. Olson underpins the role of the neuromuscular system in modulating its motor control strategy to gauge the muscle activation levels. The test posture has been identified as a determinant of muscle activation that should be considered during designing a rehabilitation program. Baek et al. found that muscle activity ratios are significantly changes with the posture of the spine during exercises. Lee et al. encouraged clinicians to modify their exercises based on the level of muscle activation that suits subjects’ abilities. In conclusion, clinicians must arrange the order of exercises based on the level of experienced difficulties in order to improve exercise performance ability.

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Conflict of Interest
The authors declare no conflict of interest.

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