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# RESEARCH ARTICLE

## ISOKINETIC MEASUREMENTS OF SHOULDER MUSCLES PERFORMANCE IN NOTEBOOK COMPUTER USERS

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**ABSTRACT**

**Background:** The use of notebook computers has increasedand become very popular among computer users due to their light weight, small size, portability, and battery power optionand become the main cause of increased muscle activities in the neck and shoulder region between computer users.

**Purposes:** To investigate the isokinetic measurements of shoulder muscle performance in notebook computer users.

**Design:** Two groups post-test design.

**Materials and Methods:** Thirty healthy subjects were be selected from students and employees of the Faculty of Physical Therapy Cairo university. The subjects were assigned randomly into two equal groups Group (A)is fifteen subjects whoare computer users. Their mean age (22.33±1.11) years, weight (75.36±17.6) kg, height (170.13±8.5) cm and BMI (25.87±5.17) kg/m2.Group (B) is fifteen subjects who are non computer users. Their mean age (22.8±3.4) years, weight (68.26±16.9) kg, height (171.53±10.35) cm and BMI (23.58±4.11) kg/m2. All participants were tested for shoulder flexion from 90° to 180° and shoulder abduction from 15° to 135° at angular velocity 60°/ sec and 180°/ sec for both ranges to measure muscle work, torque and work fatigue of shoulder flexors and abductors using Biodex system 3 isokinetic dynamometer.

**Results:** There were no significant differences between the two groups in shoulder flexors work, torque and work fatigue at angular velocity 60°/ sec, and at angular velocity 180°/ sec. There were no significant differences between two groups in shoulder abductors work, torque and work fatigueat angular velocity 60°/ sec, and at angular velocity 180°/ sec.

**Conclusion:** Notebook computers proved to have no effect over shoulder flexors and abductors performance during shoulder movement.

## INTRODUCTION

The amount and extent of the computer use has increased and become the main cause ofneckshoulder pain and low back pain. Prolonged visual display terminal operation is a leading cause of musculoskeletal disorders and cumulative trauma disorders such as shoulder and neck pain, stiff shoulders,low back pain and carpal tunnel syndrome among office employees. The problems are intensified by wrong work postures, e.g., flexed neck, wrists, or excessively flexed forearms(Jamjumrus and Nanthavanij, 2008).The use of the notebook computers(NBC)with lower screen heights and increased neck flexion were associated with increased muscle tension in the neck and shoulder region. This posture would increase mechanical loading of the spine, possibly contributing to musculoskeletal discomfort. Comparing postural constraints and discomfort during desktop computer and (NBC) operations. The results revealed that desktop computer users felt better even after 20 min of computer use (Burgess-Limerick, 2000).

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Neck and shoulder complaints occurred significantly more often than complaints in the other parts of the upper extremities. Neck, and shoulder and forearm / hands complaints were positively associated with irregular head and body posture and job demands and computer usage which increased during last decade(Eltayeb*et al.,* 2009; Blatter and Bongers, 2002; Jensen, 2003).Musculoskeletal problems such as neck and shoulder discomfort are common among office employees especially those who use the computer on a regular basis. Discomfort is a symptom at the first stage. If the symptom is ignored, discomfort can develop into severe pain or a chronic disability, which has an impact on rehabilitation services, lost work time, poor work quality, low work performance, decreased motivation, and stress from sickness(MekhoraandStraker, 2000; Nanthavanij*et al.,* 2013)Isokinetic dynamometry used to obtainobjective and reliable measurements of muscle strength. It provides constant velocity with accommodating resistance throughout a joint's range of motion. This resistance is provided at a user-defined constant velocity. It used to assess dynamic muscle function in both clinical and research settings to obtain objective measurements of human muscle function on variables related to torque, power, and endurance. Adequate patient stabilization

and clear instructions during the test are fundamental for good quality and reproducible data (Drouin*et al.,* 2004; Andrade*et al.,* 2016). The purpose of this study is to investigate the isokinetic measurements of shoulder muscle performance in notebook computer users.

## MATERIALS AND METHODS

This study was conducted in Isokinetic Laboratory of Physical Therapy CairoUniversity to investigate the isokinetic measurements of shoulder flexors and abductors performance in notebook computer users. Thirty healthy subjects were be selected from students and employees of the Faculty of Physical Therapy Cairo university,with age ranged from 20 to 40 years old.Exclusive criteria include any history of trauma or musculoskeletal disordersin shoulder girdle, upper limb or neck region, any neurological disorders that affect muscular performance, Athletic subjects who practice sports that require use of shoulder muscle group such as volleyball….etc or subjects taking any muscle relaxant.Inclusive criteria include Thirty healthy subjects of both sexes with sedentary life style and age ranged from 20 to 40 years old. All the subjects will be right handed. Computer users (study group) subjects use notebook computers at least 2 hours per day. Eachsubject read and signed a consent form before starting procedure.Subjects wererandomly assignedinto 2 equal groups, study groupnotebookcomputer users (group A)is 15 subjects and control group non notebookcomputer users ( group B) is 15 subjects.

**Design of study**

2 groups post-test design was used in the study to investigate the isokinetic measurement of shoulder flexor and abductor muscles in notebook computer users.

**Instrumentation**

**1-Isokinetic dynamometer**

Biodex system 3 multi-joint testing and rehabilitation system (Biodex medical system, Shirly, NewYork, USA) It is one of recent computerizeddevices that was available in this study in Faculty of Physical Therapy. Itconsists of a dynamometer, a chair and a control panel that can be controlled by computer. The machine is provided with many attachments and isolation straps for trunk, shoulder. It measures the peak torque, work and fatigue of shoulder muscles.

**2-Standard weight and height scales**: will be used to measure the weight and height of each participant to calculate the body mass index.

**A-Evaluative procedures**

Subjects participated in this study, were given an explanatory session before the evaluation procedures to be aware of the different test steps and signed the informed consent form.All testing was performed in the same place under the same conditions by the principle investigator. Body weight and body height were measured for each subject by weight and height scale in isokinetic laboratory. Subjects wear loose fitting, comfortable clothes.For all testing, a minimum of five minutes was permitted between the testing of the different movement patterns, and a minimum of two minutes between testing at the different velocities. Verbal encouragement for maximal speed, and as full a range of motion as possible, was provided throughout the testing procedure.

**B- Measurement procedure**

**1-Isokinetic testing of shoulder flexors**

**Subject position:** the subject was in sitting position with the axis ofrotation ofthe shoulderjoint aligned with the axis ofrotation ofthe dynamometer armfacing the acromion process. The handgrip and lever arm will be adjusted to permit full elbow extension.

**Fixation and stabilization:** Padded straps will be used to fix and stabilize the trunk of the subject to avoid substitutions and ensure the performance of the movement through out the pre-assumed plane and range of motion.

**Range of motion:** From 90°shoulder flexion (arm pointed forward at shoulder level)to 180° shoulder flexion (arm pointed straight up).

**Speed of test:** Two different speeds will be used; 60 degree/sec and 180 degree/sec (Yen, 2005).

**Repetitions:** five maximal repetitions for each testing speed with rest periods of two minutes in between.

**Calibration:** The dynamometer will be calibrated prior to every testing and according to instructions of manufacturer.

**2-Isokinetic testing of shoulder abductors:**

**Subject position:** The subject was in sitting position. The center of rotation of the shoulder joint (defined 5 cm below the acromion) was aligned to the center of rotation of the dynamometer arm, by adjusting the height and forward-backward direction of the dynamometer and tilting the dynamometer 15 degree from the frontal plane.

**Fixation and stabilization:** Padded straps will be used to fix and stabilize the trunk of the subject to avoid substitutions and ensure the performance of the movement through out the pre-assumed plane and range of motion.

**Range of motion:** From 15° to135°of shoulder abduction.

**Speed of test:** Two different speeds will be used; 60°/sec and 180°/sec.

**Repetitions:** Five maximal repetitions for each testing speed with rest periods of two minutes in between.

**Calibration:** The dynamometer will be calibrated prior to every testing and according to instructions of manufacturer. The data concerning peak torque, work and work fatigue of shoulder flexors and abductors collected by Biodex system 3 isokinetic dynamometer.The analyses of data include descriptive statistics of means and standard deviation of subjects characteristics. Independent t- test will be used to show the significant difference betweenstudy group and control group.

## RESULTS

The data in Table (1) and demonstrated in Fig. (1)represent the mean ± SD of age, height, weight and body mass index (BMI) of both groups.

**Table 1. General Characteristics of subjects in both groups**

| General characteristics | Age (yrs) | Weight (kg) | Height (cm) | BMI (kg/m$^2$) |
|---|---|---|---|---|
| Group A Mean ±SD | 22.33±1.11 | 75.36±17.6 | 170.13±8.5 | 25.87±5.17 |
| Group B Mean ±SD | 22.8±3.4 | 68.26±16.9 | 171.53±10.35 | 23.58±4.11 |
| t-value | -0.494 | 1.124 | -0.362 | 1.346 |
| P-value | 0.628 | 0.271 | 0.720 | 0.189 |

**Table 2. Mean values of Shoulder flexors performance for both groups**

| Shoulder flexors performance | 60° /sec | | | 180° /sec | | |
|---|---|---|---|---|---|---|
| | Work (joules) | Torque (n.m) | Fatigue | Work (joules) | Torque (n.m) | Fatigue |
| Group A Mean ±SD | 41.2±12.3 | 44.8±21.5 | 39.3±5.9 | 31.1±10.5 | 47.6±15.6 | 22.4±3.4 |
| Group B Mean ±SD | 47.7±18.6 | 51.6±20.6 | 28.1±3.4 | 25.4±10.2 | 49.76±17.4 | 16.2±3.1 |
| t-value | -1.137 | -0.833 | 0.781 | 2.026 | -1.253 | 1.282 |
| P-value | 0.265 | 0.385 | 0.442 | 0.072 | 0.221 | 0.210 |

**Table 3. Mean values of Shoulder abductors performance for both groups**

| Shoulder abductors performance | 60° /sec | | | 180° /sec | | |
|---|---|---|---|---|---|---|
| | Work (joules) | Torque (n.m) | Fatigue | Work (joules) | Torque (n.m) | Fatigue |
| Group A Mean ±SD | 66.8±18.9 | 41.8±17.6 | 13.8±5.9 | 51.8±18.8 | 39.1±12.4 | 16.1±5.1 |
| Group B Mean ±SD | 73.3±20.5 | 47.8±14.8 | 19.1±6.5 | 48.3±15.2 | 38.9±11.1 | 23.4±8.1 |
| t-value | -1.626 | -1.014 | -1.206 | 0.389 | 0.037 | -1.47 |
| P-value | 0.115 | 0.319 | 0.238 | 0.701 | 0.971 | 0.153 |

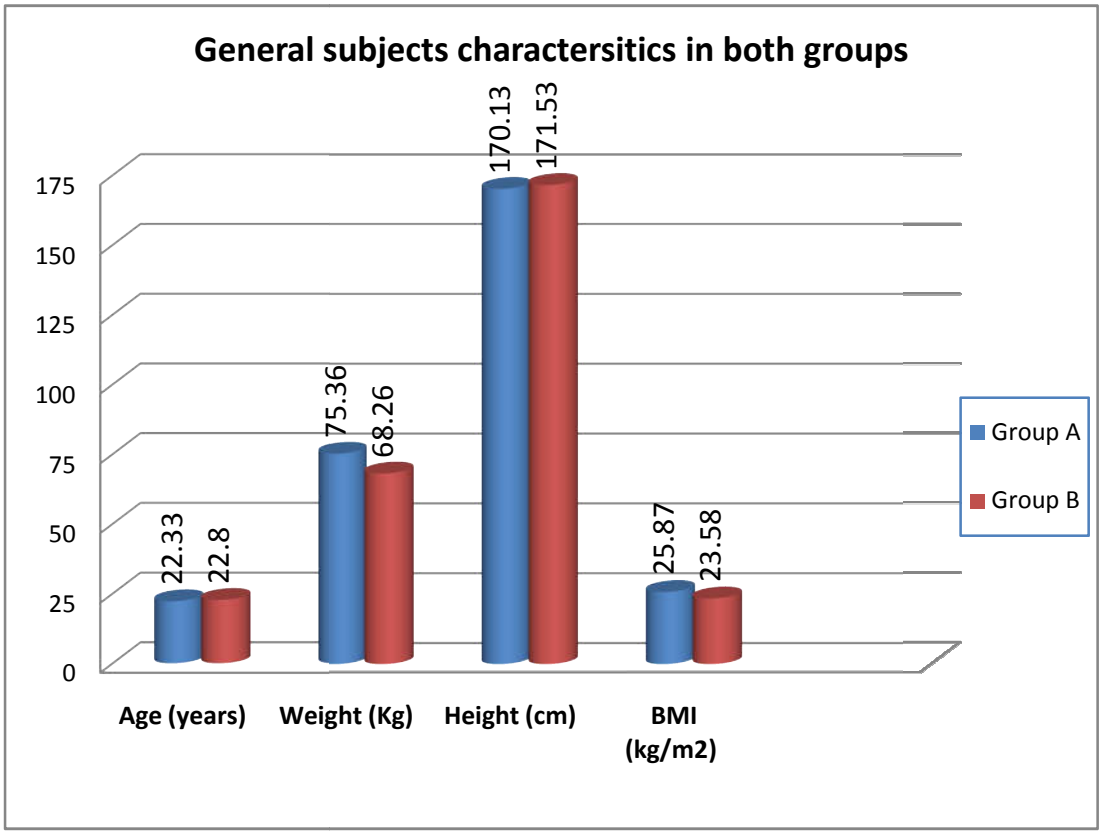


**Figure 1. General Characteristics of subjects in both groups**

There were no statistical significant differences between two groups in their mean age, weight, height and BMI, where P-values were (0.84), (0.78), (0.66) and (0.257) respectively.Data in Table (2) and demonstrated in Fig. (2)and Fig. (3) showed there were no significant differences between two groups in shoulder flexors work, torque and work fatigue at angularvelocity60°/sec,whereP-valueswere(0.265), (0.385).and (0.442) respectively and at angularvelocity 180°/ sec, where P-values were (0.072), (0.221) and (0.210) respectively Data in Table (3)showed and demonstrated in Fig. (4) and Fig. (5),there were no statistical significant differences between two groups in shoulder abductors work, torque and work fatigue at angular velocity 60°/ sec, where P-values were (0.115), (0.319) and (0.238) respectively and at angular velocity 180°/ sec, where P-values were (0.701), (0.971) and (0.153.) respectively.

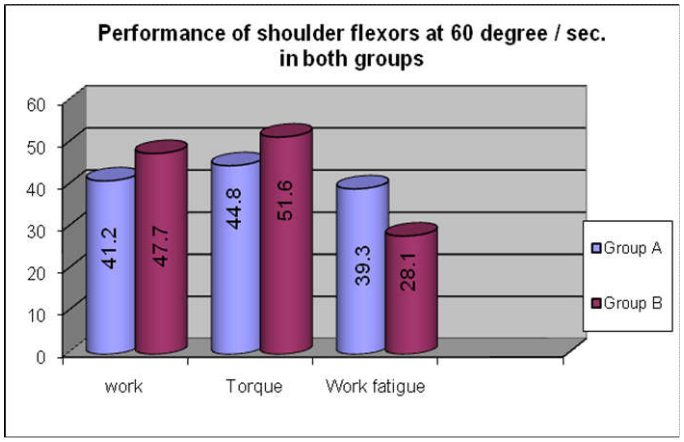


**Figure 2. Shoulder flexors performance at 60°/ sec in both groups**

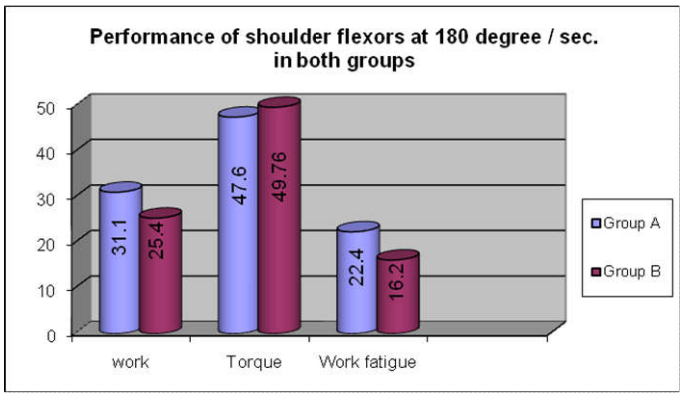


**Figure 3. Shoulder flexors performance at 180°/ sec in both group**

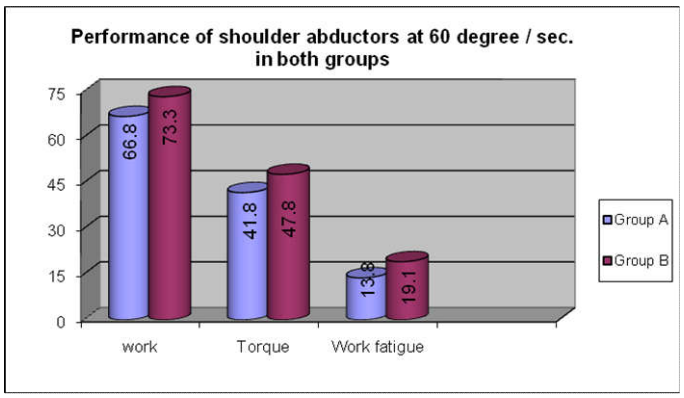


**Figure 4. Shoulder abductors performance at 60°/ sec in both groups**

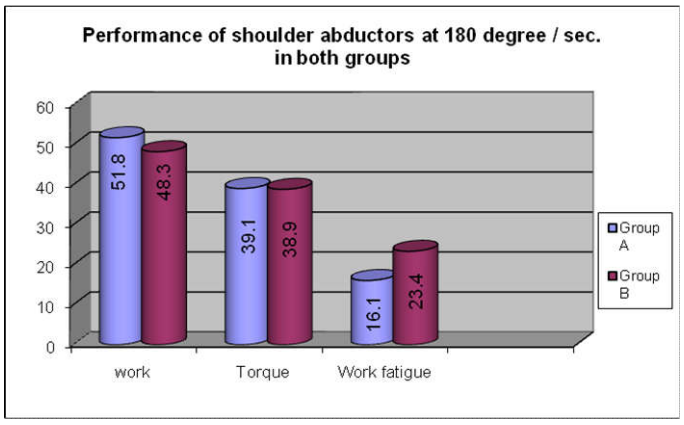


**Figure 5. Shoulder abductors performance at 180°/ sec in both groups**

## DISCUSSION

The aim of the current study was to identify the difference between notebook computer user subjects group (A) and non-notebook computer user subjects group (B) in peak torque and work (i.e isokinetic strength) and in work fatigue index (i.e isokinetic endurance).Two different muscle groups of shoulder (shoulder flexors and shoulder abductors) were tested isokinetically at two different angular velocities(60°/sec and 180°/sec).The results of the current study revealed that there were no significant differences between the two groups in shoulder flexors work, torque and work fatigue at angular velocity 60°/ sec, where P-values were (0.265), (0.385) and (0.442) respectively and at angular velocity 180°/ sec, where P-values were (0.072), (0.221) and (0.210) respectively. There were no significant differences between two groups in shoulder abductors work, torque and work fatigue at angular velocity 60°/ sec, where P-values were (0.115), (0.319) and (0.238) respectively and at angular velocity 180°/ sec, where P-values were (0.701), (0.971) and (0.153) respectively.The results of the current study were in agreement withergonomic researches who suggest that visual display terminal VDT workstations which promote constrained work postures predispose users towards musculoskeletal injuries (Jamjumrus and Nanthavanij, 2007).

While (Jalil and Nanthavanij, 2007) introduced adjustment recommendations such as adding footrest, seat support, base support, etc. so that the correct work posture can be obtained while operating NBCs. Accessories are utilized to adjust the height and tilt angle of NBC and the user's seat height.These results were in agreement with (Jalil and Nanthavanij, 2007) whose study indicated that there is no significanteffect over shoulder muscles when notebook computer(NBC) user is sitting with shoulder flexion is no more than 20° and neck flexion is no more than 10°. The viewing distance should be between 38 and 62 cm between the subject's body and (NBC) will help to keep the shoulder flexion from exceeding 20° in order to minimize discomfort.In agreement with the current study who found no relationships between isokinetic neck/shoulder lifting strength and static endurance of shoulder muscles and the risk of shoulder pain. Moreover the current study agree with who stated that no clear evidence for abnormal muscle activation patterns in work related musculoskeletal disorders patients compared to healthy controls.The results were in disagreement with (Szeto*et al.,* 2005a, 2005b; Westgaard and DeLucam 2001) who reported thatmost subjects positioned their (NBC) too far from their body, This action forces them to extensively flex their shoulders in order to reach the screen. It also increases the viewing distance which causes several subjects to lean forward in order to view the screen. Static upper limb postures associated with computer use has been linked with prolonged low level muscle activity in neck–shoulder stabilizers, which in turn may contribute to substantial loading in the musculoskeletal system.

### Conclusion

Notebook computers proved to have no effect on shoulder flexors and abductors performance during movement using Biodex Isokinetic dynamometer at angular velocities 60°/ secand180°/ sec.

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