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Standardized upper limb's range of motion for egyptian subjects

Reda Kotb Abd Elrazik Gad Elhak[1], Reham M Abd Elrahim[2], Sara Samir[3], Yomna Farag Ahmed[2]
[1] Lecturer of Physical Therapy, Department of Physical Therapy for Musculoskeletal Disorders and Its Surgery, Faculty of Physical Therapy, Banha University, Banha, Egypt
[2] Lecturer of Physical Therapy, Department of Basic Science, Faculty of Physical Therapy, Modern University for Technology and Information, Cairo, Egypt
[3] Lecturer of Physical Therapy, Department of Physical Therapy for Musculoskeletal Disorders and Its Surgery, Faculty of Physical Therapy, Cairo University, Cairo, Egypt

Abstract
Background: Clinical measurements of joint's motion are routinely used to assess injuries and diseases in the locomotors system. Normal reference values are needed to assess the extent of impairment and to monitor joint's motion. There was no study, in which joint motion in normal Egyptian populations has been surveyed and reported. So there is a critical need to gather a new data of Egyptian citizens ROM.
Purpose: To have a standard upper limb's Range of Motion for Egyptian Subjects.
Materials and Methods: 1000 normal Egyptian male and female subjects aged between 21 and 50 years, free from any conditions cause limitation joint mobility, enrolled with ethical approval and informed consent as a random sample were recruited from variety of settings such as community gatherings, schools, scientific meetings and workplaces. Three licensed physical therapists measured Upper limb joints ROM using digital goniometer to determine active joint motion of the upper limb bilaterally.
Results: Range of motion average values for all joints decreased for both right and left side. The results were significantly different than most commonly used normative values.
Conclusion: Our study showed a new reference value for upper limb joints ROM in Egyptian subjects.

Keywords: upper limb, range of motion, digital goniometry, normative values, reference values

Introduction

Upper-limb motions are very important for the subject daily activities, such as eating, drinking, brushing teeth, combing hair and washing face. [1] It is well recognized that the upper limb works as a mechanical linkage unit and that immobilization of one part has a potential impact on movement patterns of the entire upper limb. [2]

The pendular motion of the upper extremities is a basic component of human gait. During normal walking, humans swing their upper limbs alternately, each upper limb swinging in phase with contra lateral lower limb. Arm and leg movements are linked during locomotion and a defined frequency relationship between arm and leg movements is present. The role of the upper limb during walking is demonstrated by the alteration of gait pattern after limb constraining both in a healthy and in a pathologic population. Especially in pathologic individuals, upper extremity movements may provide crucial information about the walking strategy. In some pathology, such as muscular disease and stroke, the upper limbs play a relevant role in balance and stability maintenance, reduction of mechanical loads on tissue, and improved gait efficiency. However, the assessment of kinematics and kinetics of the upper extremities has generally not received as much scientific attention as the lower limbs. [3]

The upper extremity is divided into five functional units: shoulder girdle, shoulder joint, elbow joint, radio-ulnar joint, wrist and hand. These functional units work together to promote efficient upper limb function. [4] Active range of motion (AROM) assessment is therefore often used as an indicator for upper extremity function. [5]

In clinical practice, (AROM) assessment represents a quantitative method to evaluate movement and functional status of an impaired upper extremity. [6] Accurate and reliable assessment of upper extremity is critical for diagnosis and characterization of various neuromuscular conditions and injuries, for tracking progress of therapy and to evaluate effects of drug or surgical interventions. [5]

Goniometry is a frequently used tool for measurement and documentation of range of motion during a physical therapy examination. Digital Goniometers are easy to apply; it has a Validity & reliability in measurement joints ROM. [7]

Material and methods

1. Ethics

The study was ethically approved by the Institutional Ethical Committee of the Faculty of Physical Therapy, Cairo University, Egypt (No: P.T.REC/012/002307). All patients read and signed two copies of a consent form before the beginning of data collection.

This study was conducted at the outpatient clinic at the Faculty of Physical Therapy, MTI University, between 15 March 2019 to 20 august 2019 on MTI University.

2. Study design
Study design is a cross-sectional observational study.

3. Subject selection
1000 healthy subjects (280 male and 720 female) were participated in the study. They were selected by using random sampling technique using folded paper from variety of settings such as community gatherings, schools, scientific meetings and workplaces in Egypt. Subjects were included if their age ranged between 21 and 50 and Their BMI ranged from 18 to 25 kg/m2.The exclusion criteria for participants were We excluded participants with any musculoskeletal disorders, congenital anomalies, complain from chronic pain before.

4. Methods
Digital Goniometer powered by one 9V battery, power coated steel with inch/cm marks printed onto arms, 2 Stainless steel rules with 7" and 4" blades with photo etched graduations in mm, 1/16", 1/32" and 1/64" with large clear LCD display Resolution: 0.05 degree (that's 5/100th of a degree!), Accuracy: +/- 0.2 degree, Repeatability: 0.05 degree, Battery: 3V CR2032 with life of approximately 1 year and comes with an extra battery. [7]

5. Procedures of the study
The study was conducted between 15 March 2019 to 20 November 2019 on MTI university. Participants were asked to wear light clothing to allow for better identification of the bony landmarks and to avoid motion restrictions. Before recording any measurement, the tested movements were practiced three times bilaterally to familiarize the participants with the procedure and the motions being measured. Three licensed physical therapists measured Upper limb joints ROM using digital goniometer.
Before measuring the motion, Digital goniometer calibrated to zero prior to each participant being measured, a pen marker was used to draw cross marks on preselected anatomical landmarks on the tested upper limb. Using these marks, we quantified the following upper limb movements that each participant performed at a maximum (end-range) joint movement at each participant's own pace:
Shoulder Flexion-AROM: a cross mark was placed on the lateral aspect of the center of the humeral head approximately below the acromion process (fulcrum). One cross mark was placed along the mid shaft of the humerus aligned with the greater tuberosity and lateral epicondyle of the humerus; one additional cross mark was placed along the midline of the thorax. [8] Flexion-AROM was assessed with the participant in supine position on a standard plinth. The arm was actively elevated in a strict sagittal plane with the thumb pointed up toward the ceiling.
Shoulder Extension-AROM: Shoulder Abduction-AROM: a cross mark was placed on the coracoid process (fulcrum). One cross mark was placed along the shaft of the humerus, and an additional cross mark was placed along the midline of the thorax. [8] Abduction-AROM was measured with the participant in the supine position, as in flexion-AROM. The arm was actively elevated in the strict coronal plane with the thumb pointed up toward the ceiling. This allowed for the required ER necessary to avoid impingement of the greater tuberosity on the acromion process. Shoulder external rotation(ER) and internal rotation (IR) AROM: a cross mark was placed at the olecranon process (fulcrum), and another cross mark was placed at the ulnar styloid process. [8] Both ER and IR AROM were tested with the participant in supine position. The tested arm was supported on the table at 90° abduction, the elbow was flexed to 90°, and the wrist was neutral. A towel roll was placed under the humerus to ensure neutral horizontal positioning and to approximate the plane of the scapula, and a weighted bag was used to prevent unwanted scapular movements. Once positioned, the participant was asked to rotate the arm back into ER and to rotate the arm forward into IR to their available end-range without any discomfort. The participant was instructed not to lift the lower back during this measurement.
Elbow flexion, extension -AROM: a cross mark was placed on the lateral epicondyle (fulcrum). One cross mark was placed along the lateral midline of humerus; one additional cross mark was placed along the lateral midline of the radius. [8] Both movements-AROM was assessed with the participant in supine position with arm rested on a standard plinth. The forearm was actively moved upward into flexion and downward in extension with supinated hand.
Wrist flexion-extension AROM: a cross mark was placed on the lateral triquetrum (fulcrum). One cross mark was placed along the lateral midline of ulna; one additional cross mark was placed along the lateral midline of 5th metacarpal. [8] Both movements-AROM was assessed with the participant in seated position with shoulder at 90° abduction; elbow flexed to 90°; forearm supported on surface with palm facing the floor; wrist and hand free to move.
Wrist ulnar and radial deviation AROM: a cross mark was placed on the dorsal capitate (fulcrum). One cross mark was placed along the dorsal midline of forearm; one additional cross mark was placed along the dorsal midline of 3rd metacarpal. 8 Both movements-AROM was assessed with the participant in seated position with shoulder at 90° abduction; elbow flexed to 90°; forearm and hand supported on surface with palm facing the floor. The hand was actively moved inward into radial deviation and outward into ulnar deviation

Data analysis and statistical design
Statistical analysis was conducted using SPSS for windows, version 25 (SPSS, Inc., Chicago, IL). The current test involved ROM of shoulder movements (flexion, extension, abduction, adduction, internal rotation and external rotation) elbow flexion and extension, wrist flexion, extension, radial and ulnar deviation.
Date where collected from 1000 subjects 720 females and 280 males. As The study was performed on a random sample of 1000 subjects 720 (72%) females and 280 (28%) females, Their ages mean value was (30.36± 6.941), the Max. value was (50) and Min. value was (21) years. study. The mean height±SD and the mean weight±SD was 68.9±7.2 kg.
Descriptive statistics used are minimum, maximum, mean±SD, median and inter quartile range (IQR).Farther more, 10%, 25% (1st quartile), 50 (median) 75%(3rdquartile) and 90% percentile rankings for ROM scores in all subjects are shown in table (1). If a person had a score at the 25th percentile, 25 percent of the population scored lower than him/her and so on. These tables allow readers to see the distribution of data and, and how other participants compare to this sample of participants as a stander value. Prior to final analysis, data were screened for normality assumption. Kolmogorov-Smirnov test for

normality showed that data is not normally distributed, so nonparametric test where used for comparison. Wilcoxon Signed Ranks Test used for related sample comparison between right and left side in the same subject, and Mann-Whitney U test used for comparison between independent sample, male and female values. Intestinal alpha level was 0.05 for all tests.

Table 1: Descriptive statistics of joints ROM in all subjects

ROM	Min	10%	25%	50%(median)	75%	90%	Max	IQR	Mean	SD
Sh. Flex.Rt.	130	150	160	170	176	180	180	16	166.97	12.092
Sh. Flex.Lt.	120	150	160	170	175	180	180	15	165.98	12.799
Sh. Ext.Rt.	40	50	55.25	60	60	60	70	4.75	57.77	4.936
Sh. Ext.Lt.	40	50	55	60	60	60	70	5	57.25	5.237
Sh. Abd.Rt.	120	150	160	170	175	180	180	15	166.24	12.941
Sh. Abd.Lt.	130	150	160	170	175	180	180	15	166.21	12.696
Sh. Int. rot.Rt.	50	60	60	67	70	70	80	10	65.23	5.391
Sh. Int. rot.Lt.	50	60	60	65	70	70	80	10	65.22	5.3
Sh. Ext. rot.Rt.	65	79	80	86	90	90	90	10	84.98	5.801
Sh. Ext. rot.Lt.	70	75	80	85	90	90	90	10	84.76	5.58
El. Flex.Rt.	115	120	125	130	135	135	140	10	128.97	5.865
EL. Flex.Lt.	110	120	125	130	135	135	140	10	128.9	6.222
El. Ext.Rt.	-1	0	0	0	0	0	5	0	0.38	1.376
El. Ext.Lt.	-1	0	0	0	0	0	5	0	0.39	1.37
Wr. Flex.Rt.	60	68.2	70	76	80	80	90	10	75.8	6.449
Wr. Flex.Lt.	60	65.1	70	75	80	80	90	10	75.58	6.895
Wr. Ext.Rt.	50	60	60	65	70	70	80	10	64.74	5.962
Wr. Ext.Lt.	45	55	60	65	70	70	80	10	64.02	6.432
Rad.Rt.	11	15	15	19	20	20	21	5	17.815	2.502
Rad.Lt.	10	15	15	19	20	20	20	5	17.78	2.58
Uln.Rt.	20	22	25	28	30	30	30	5	27.04	3.263
Uln.Lt.	15	22	25	27	30	30	30	5	26.71	3.319
ROM	Min	10%	25%	50%(median)	75%	90%	Max	IQR	Mean	SD
Sh. Flex.Rt.	130	150	160	170	176	180	180	16	166.97	12.092
Sh. Flex.Lt.	120	150	160	170	175	180	180	15	165.98	12.799
Sh. Ext.Rt.	40	50	55.25	60	60	60	70	4.75	57.77	4.936
Sh. Ext.Lt.	40	50	55	60	60	60	70	5	57.25	5.237
Sh. Abd.Rt.	120	150	160	170	175	180	180	15	166.24	12.941
Sh. Abd.Lt.	130	150	160	170	175	180	180	15	166.21	12.696
Sh. Int. rot.Rt.	50	60	60	67	70	70	80	10	65.23	5.391
Sh. Int. rot.Lt.	50	60	60	65	70	70	80	10	65.22	5.3
Sh. Ext. rot.Rt.	65	79	80	86	90	90	90	10	84.98	5.801
Sh. Ext. rot.Lt.	70	75	80	85	90	90	90	10	84.76	5.58
El. Flex.Rt.	115	120	125	130	135	135	140	10	128.97	5.865
EL. Flex.Lt.	110	120	125	130	135	135	140	10	128.9	6.222
El. Ext.Rt.	-1	0	0	0	0	0	5	0	0.38	1.376
El. Ext.Lt.	-1	0	0	0	0	0	5	0	0.39	1.37
Wr. Flex.Rt.	60	68.2	70	76	80	80	90	10	75.8	6.449
Wr. Flex.Lt.	60	65.1	70	75	80	80	90	10	75.58	6.895
Wr. Ext.Rt.	50	60	60	65	70	70	80	10	64.74	5.962
Wr. Ext.Lt.	45	55	60	65	70	70	80	10	64.02	6.432
Rad.Rt.	11	15	15	19	20	20	21	5	17.815	2.502
Rad.Lt.	10	15	15	19	20	20	20	5	17.78	2.58
Uln.Rt.	20	22	25	28	30	30	30	5	27.04	3.263
Uln.Lt.	15	22	25	27	30	30	30	5	26.71	3.319

Discussion

Standardization or standardisation is the process of developing and implementing technical standards. To have a Standard chart for upper ROM in each country all over the world is consider important issue, as the range of motion has variability between individuals according to their age, sex, culture and job in the same country. So, there were a variation between every country and another, as a result of their difference in activity of daily living.

Evaluating the range and patterns of movement is a key concern for a clinician in the diagnostic and functional assessment of patients with musculoskeletal disease. [9] This study quantified motion of the full upper limb in healthy participants.

In the present study, normative values for the upper limb range of motion derived from a population of 1000 healthy

volunteers are presented. Measuring active upper limb motion, in which other studies measured the passive ROM of the upper limb [10, 11]. Other studies measured the upper limb ROM during activities [12], while in our study we measured the upper limb ROM in normal events.

Many studies have quantified motion of the upper limb, they have varied significantly in their choice of tasks and in the methods used to measure joint angles, both in equipment used and in how the segments have been defined. This variation makes direct comparison among studies difficult. In addition, studies have typically focused on assessing a single joint. [10-16]

But there was no researches focused on Upper limb range of motion in Egypt.

The shoulder is the most mobile joint in the body, and it allows orientation of the upper limb as required. [15] The anatomical structure of this joint enables it to have an incredible amount of freedom with six movements (flexion, extension, abduction, adduction, internal and external rotation). [16] According to ROM Chart 2011. [17] shoulder flexion ROM was 0–180°, shoulder abduction 0–180°, shoulder internal rotation 0–70° and external rotation 0–90°, while in this study shoulder flexion ROM was 0–180°, shoulder abduction 0–180°, shoulder internal rotation 0–80° and shoulder external rotation 0–90°.

The elbow, through flexion-extension movements, brings the hand closer or moves it away from the body [18]. According to ROM Chart 2011. [17], Elbow flexion 0–150°, Elbow Extension 150-0 ° while in this study Elbow flexion 0–140°, Elbow Extension 0-5°.

Distal to the elbow, the combined movements of the wrist and forearm place the hand in a position for grasping. The hand moves within a large volume in space, the shoulder being the apex; it can reach any part of the body fairly easily because of the mobility of the shoulder as well as that of the elbow and the wrist, all operating in different planes. [19] According to ROM Chart 2011. [17], Wrist flexion 0–80°, Wrist extension 0–70°, ulnardeviation 0-30°, radialdeviation 0-20° while in this study Wrist flexion 0–90°, Wrist extension 0–80°, ulnardeviation 0-30°, radialdeviation 0-20°.

Limitations

With this study are important to address when interpreting the results, the sample size was small.

Recommendations

With this study are important to address the standard Upper limb Range of motion in different countries all over Egypt, as a result of variation in habitual daily living & further studies are required to investigate. 1) Make standardization of lower limp ROM.

Conclusion

The result of this study design a recent upper limb ROM chart, which can be used as a normal reference value in the physical therapy assessment process.

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Conflict of interest

None.

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