How to Cite:
Singh , N., Kumar , P., & Parasher , R. K. (2022). Inter-tester and intra-tester reliability of physical examination test used to measure positional faults of the shoulder girdle in healthy individuals. *International Journal of Health Sciences*, *6*(S7), 3771–3780.
https://doi.org/10.53730/ijhs.v6nS7.12626

Inter-tester and intra-tester reliability of physical examination test used to measure positional faults of the shoulder girdle in healthy individuals

Neeraj Singh MPT
Ph.D. Scholar, Amity Institute of Physiotherapy, Amity University, Noida

Pragya Kumar Ph.D
Assistant Professor, Amity Institute of Physiotherapy, Amity University, Noida
Corresponding Author email: pkumar24@amity.edu

Raju K Parasher Ph.D
Director, Amar Jyoti Institute of Physiotherapy, University of Delhi, Delhi

Abstract---Introduction Sustained, repetitive, prehensile activities that require precision and stability, necessitate a sustained static shoulder girdle posture over long periods of time, which can result in abnormal activation of the shoulder girdle musculature and consequent scapular misalignments. Aim, Aim of this study was to establish test-retest and inter-tester reliability of six (6) clinical tests commonly used to measure parameters related to shoulder girdle positional faults and or asymmetries. Material and Methods A convenience sample of 100 healthy 18–25-year-old, male college students were evaluated on the following tests: Pectoralis minor index, Lateral scapular slide test, Posterior capsular tightness, Forward shoulder posture, cervical range of motion, and shoulder muscle Isometric strength. Participants were tested twice one week apart by one tester for test-retest reliability and for inter-rater reliability four (4) testers measured participants on each test independently. Result Intra-class correlations (ICC) were calculated across trials (test-retest) and across testers (inter-rater) in a repeated measure ANOVA.Test-retest ICC for forward shoulder posture (0.998), Cervical range of motion (0.987 to 0.999), Isometric shoulder strength (0.986-0.997), Pectoralis minor index (0.982 to 0.984), Lateral scapular slide test (0.997- 0.969) and Posterior Capsular Tightness (0.967 to 0.974) was found to be excellent but Inter-rater and reliability values were in the poor to moderate ranges. Conclusion Clinical tests used to measure parameters relevant to shoulder girdle positional faults and or asymmetries met the criteria

for excellent test-retest reliability by one tester, but inter-tester values were in the poor to moderate range.

***Keywords*---**Inter-tester reliability, Intra-tester (test-retest) reliability, shoulder girdle, clinical test, positional fault.

Introduction

Upper extremity and cervical dysfunction are often associated with dyskinesia and or positional faults of the shoulder girdle and aberrant neck and shoulder kinematics.[1] It has been suggested that, repetitive activities of the upper extremity that necessitate stabilization of the shoulder girdle for sustained periods of time lead to adaptive muscle shortening, pain, movement dysfunctions, and weakness of the shoulder girdle musculature.[2,3,4] It is purported that these deficits, over a period of time can potentially lead to positional faults and consequently a disturbance of the scapulohumeral rhythm and shoulder girdle dyskinesia.[5] Thus, scapular misalignment or dyskinesis can be a result of muscle imbalance, abnormal soft tissue strain, and altered force transmission across the shoulder girdle that can result in shoulder instability and injuries in previously asymptomatic individuals.[6,7,8]

Given the close link between shoulder girdle asymmetries and shoulder joint pathologies and or dysfunction, it might be prudent to add a comprehensive assessment of the shoulder girdle in clinical practice so as to devise effective long-term management strategies.[9] Several clinical tests, such as forward shoulder posture, posterior capsular tightness, pectoralis minor shortening, etc. related to shoulder girdle examination provide substantial information with regards to the number of deviations and or positional faults of the shoulder girdle at rest or during upper extremity activities. As a first step, measuring the reliability of these clinical tests is essential to determine which of these tests should or can be used in the objective evaluation of shoulder girdle dysfunction following the treatment. Thus, the objective of this study was to establish test-retest and intertester reliability of clinical tests used to assess shoulder girdle positional faults.

Materials and Methods

A convenience sample of 100 healthy,18–25-year-old, male college students were recruited as volunteers and gave consent to participate in the study. Students with neck and /or shoulder pain, congenital spinal abnormalities, upper limb fractures, and if obese were excluded from the study. Participants were screened for inclusion and exclusion criteria and were then tested in random order on all six (6) clinical tests. For inter-tester reliability, four testers (two licensed physical therapists & two postgraduate physiotherapy students) were trained on measurement procedures for all the clinical tests to ensure consistency of testing. Training sessions consisted of reviewing the measurement procedure and having each trainer practice on one another until they were proficient with each of the clinical tests. For test-retest reliability, measurement data from a fifth trained tester were taken twice, five days apart, and were used for analysis. Participants were tested in random order on clinical tests as per the protocol defined in Table

1-Bony landmarks were palpated and marked with a marker for each test measurement as described in Table 1. Participants were asked to assume a relaxed and neutral posture to avoid postural over-corrections. Markings were removed after each measurement to ensure repeat palpation of bony landmarks by each and from one test to the next.

Table 1
Description of clinical tests used to measure parameters related to positional faults of the shoulder girdle

S.N.	CLINICAL TEST	DESCRIPTION
1.	**PECTORALIS MINOR INDEX MEASUREMENT (PMI)**	Muscle length of the pectoralis minor is measured from the caudal edges of the 4th rib to the inferomedial aspect of the coracoid process with a measuring tape. The pectoralis minor index (PMI) is calculated by dividing the resting length of the muscle in centimeters by the subject height in centimeters, multiply by 100.
2.	**POSTERIOR CAPSULAR TIGHTNESS(PCT)**	To measure PCT the subject is asked to lie supine on the plinth and the subject's arm is positioned with the shoulder in 90 degrees of abduction and 90 degrees of elbow flexion. The axis (fulcrum) of the goniometer is placed over the olecranon process and the, fixed arm is aligned parallel to the ulnar lateral margin. The examiner moves the arm into internal rotation until a capsular end feel is achieved and the measurement is recorded.
3.	**FORWARD SHOULDER POSTURE (FSP)**	FSP is a measure of the distance between the acromion process and the table (AT-distance) in supine lying. The patient is positioned supine and instructed to relax. The assessor measures the vertical distance between the posterior border of the acromion and the table bilaterally using a plastic ruler.
4.	**SHOULDER MUSCLE STRENGTH(SMS)**	***Shoulder Flexors*** – Subject sits unsupported with the arm flexed to 90 degrees in the sagittal plane and the tester holds the sphygmomanometer cuff on the subject's forearm. The tester stands behind the subject to provide a stable and effective posterior counter force for stability. The subject is asked to push upward in the sagittal plane, while the tester pushes downwards until maximum force is achieved.
		Shoulder Extensors- Subject sits unsupported with the arm extended to 20 degrees in the sagittal plane and the tester holds the sphygmomanometer cuff on the subject's forearm. The tester stands behind the subject to provide a stable and effective posterior counter force for stability. The subject is asked to push backward in the sagittal plane, while the tester pushes forward until maximum force is achieved.

		Shoulder Abductors- subject sits unsupported with the arm abduction to 90 degrees in the frontal plane and the tester holds the sphygmomanometer cuff on the subject's forearm. The tester stands behind the subject to provide a stable and effective posterior counter force for stability. The subject is asked to push upwards until maximum force is achieved.
		External Rotators – Subject sits unsupported with the arm abduction to 90 degrees, and the elbow flexed to 90 degrees in the frontal plane, while the tester holds the sphygmomanometer cuff on the dorsal surface of the subject's forearm. The tester stands behind the subject to provide a stable and effective posterior counter force for stability. The subject is asked to push upwards maintaining the elbow and shoulder at 90 degrees, while the tester pushes in the opposite direction until maximum force is achieved.
		MS of Internal Rotators – Subject sits unsupported with the arm abducted to 90 degrees, and the elbow flexed to 90 degrees in the frontal plane, while the tester holds the sphygmomanometer cuff on the volar surface of the subject's forearm. The tester stands behind the subject to provide a stable and effective posterior counter force for stability. The subject is asked to push downwards while maintaining the elbow and shoulder at 90 degrees and the tester pushes in the opposite direction until maximum force is achieved.
5.	**CERVICAL RANGE OF MOTION (CROM)**	***Flexion/Extension***- Subject was seated unsupported with axis (fulcrum) of the goniometer positioned over external auditory meatus, the stationary arm perpendicular to the floor and the moving arm aligned with nares. The patient is asked to bend the head/neck forward (to measure flexion range) and backward (to measure extension range). ***Lateral flexion***- Subject was seated unsupported with the axis (fulcrum) of the goniometer is positioned over C7 spinous process, the stationary arm perpendicular to the floor, and the moving arm aligned to occipital protuberance. The patient is asked to bend the head/neck to either side by approximating the ear to the top of the shoulder (both right & left side)
		Rotation- The subject was seated unsupported, with the axis (fulcrum) of the goniometer positioned at the vertex, with the stationary arm aligned to the acromion process and the moving arm with the tip of the nose. The patient is asked to rotate the head/neck to one side and then the other (Both right & left sides)

6	**LATERAL SCAPULAR SLIDE TEST**	The distance from the inferior angle of the scapula to the nearest vertebral spinous process was measured using a measuring tape in three positions: (1) shoulder in anatomical resting position (neutral), (2) shoulder at 40-45 degrees of frontal plane abduction with hands resting on hips, and (3) shoulder at 90 degrees abduction and complete internal rotation. [10,11,12,13,14,15]

Results

The data were analyzed by using SPSS version 17.0 Trials. Descriptive and inferential statistics were used. Results for continuous variables are presented as mean ± standard deviation. This was assumed that the observations recorded for a continuous variable had followed a normal distribution. The age of the subjects was noted. ICC estimates and their 95% confidence intervals were calculated. Two-way random-effects model was employed to estimate Inter and Inter class correlations. This model was found to be appropriate for evaluating the agreement of measurements based on different investigators or repeated measures on different occasions.

100 healthy male individuals who met the inclusion criteria were screened and measured on six clinical tests (Table 1) that measured parameters related to the assessment of positional faults of the shoulder girdle. The mean age (Mean ± Standard Deviation) of the participants was 21.67±1.93 years (range; 18 to 25 years).

A two-way random-effects model was employed to evaluate Intra class (ICC) estimates. Single measurements of four investigators for each of the clinical tests were selected to observe the Inter tester reliability and two measurements by a single tester following an interval of five days were selected for test-retest reliability. A correlation coefficient less than 0.5 show poor reliability, values between 0.50 and 0.75 shows moderate reliability, values between 0.75 and 0.9 shows good reliability, and values greater than 0.90 show excellent reliability.[16]

Table 2
Intra Class Correlations (ICC) for Test-retest and Inter-tester reliability of Pectoralis Minor Index (PMI), Forward Shoulder Posture (FSP), and Posterior Capsular Tightness (PCT) Tests

Test	Test-Retest	Inter Tester
Right PMI	0.982	0.291
Left PMI	0.984	0.422
Right FSP	0.998	0.628
Left FSP	0.998	0.633

Right PCT	0.967	0.342
Left PCT	0.974	0.295

Pectoralis Minor Index, Forward Shoulder Posture, Posterior Capsular Tightness:

As seen in table 2, test retest and intertester intraclass correlation estimates for pectoralis minor length (Right: 0.982 & 0.291 and Left: 0.984 & 0.422 respectively) and posterior capsular tightness (Right: 0.967 & 0.342 and Left: 0.974 & 0.295 respectively) at right and left sides respectively, however right-side forward posture (0.998 & 0.628 respectively) and left side forward shoulder posture (0.998 & 0.633 respectively) found to be excellent to moderate.

Table 3
Intra Class Correlation (ICC) for test-retest and inter–tester reliability of Cervical Range of Motion.

Test	Test-Retest	Inter Tester
Flexion	0.987	0.281
Extension	0.995	0.619
Right Lateral Flexion	0.978	0.091
Left Lateral Flexion	0.983	0.365
Right Rotation	0.999	0.739
Left Rotation	0.999	0.619

Cervical Range of Motion:

Test-retest Intra-class correlation estimates for flexion (0.987), extension (0.995), lateral flexion (Right:0.978, Left:0.983), rotation (Right:0.999, Left 0.999) were found to be excellent. However, Intra class correlation estimates for intertester reliability for extension (0.619) and rotation (Right: 0.739; Left: 0.619) were in the moderate range while the level of reliability for lateral flexion (Right :0.091, Left: 0.365), and flexion (0.281) were found to be in the poor range. (Ref table 3)

Table 4
Intra Class Correlations (ICC) for Test-retest and Inter-tester reliability of Shoulder Muscle Strength

Test	Test-Retest	Inter Tester
Right Shoulder Flexion	0.986	0.311
Left Shoulder Flexion	0.986	0.307
Right Shoulder Extension	0.983	0.134
Left Shoulder Extension	0.995	0.299
Right Shoulder Abduction	0.975	0.213
Left Shoulder Abduction	0.979	0.243
Right Internal Rotation	0.984	0.186
Left Internal Rotation	0.988	0.272

Right External Rotation	0.994	0.255
Left External Rotation	0.997	0.347

Shoulder Muscle Strength:

As we seen in table 4, test- retest reliability of shoulder flexion, extension, abduction, internal rotation and external rotation were found to be in excellent good to excellent range. Intra class correlation estimates for shoulder flexion (Right: 0986, Left: 0986), shoulder extension (Right:0.983, left: 0.995), shoulder abduction (Right: 0.975, Left: 0.979), internal rotation (Right: 0.984, Left: 0.988), external rotation (Right: 0.994, Left: 0.997) found to be excellent.

Furthermore, intertester reliabilities were found to be poor. Analysis revealed Intraclass correlation estimates for shoulder flexion (Right:0.311, Left: 0.307), shoulder extension (Right: 0.134, Left: 0.299), shoulder abduction (Right: 0.213, Left: 0.243), internal rotation (Right: 0.186, Left: 0.272), external rotation (Right:0.255, Left :0.347)

Table 5
Intra Class Correlation (ICC) for test-retest and Inter-tester reliability of Lateral Scapular Slide Test: Position I (neutral), II (45° abduction), & III (90° abduction).

Test	Test-Retest	Inter Tester
Right Scapular Distance in Position-I	0.997	0.608
Left Scapular Distance in Position-I	0.996	0.753
Right Scapular Distance in Position-II	0.975	0.796
Left Scapular Distance in Position-II	0.973	0.773
Right Scapular Distance in Position-III	0.973	0.645
Left Scapular Distance in Position-III	0.969	0.670

Lateral Scapular Slide Test-Position I(neutral), II (45° abduction), & III (90° abduction):

Test-retest reliability estimates for position-I (Right:0.997, Left: 0.996), scapular distance in position-II (Right:0.975, Left:0.973) and scapular distance in position-III (Right:0.973, Left:0.969) were found to be excellent. Further, investigation revealed that reliability estimates for scapular distances in position-I (Right:0.608, Left:0.753) for scapular distances in position-II (Right:0.796, Left:0.773) and for scapular distance in position-III (Right:0.645, Left:0.670) found to be moderate.

Discussion

The present reliability study involved five investigators, and the “mean of three investigators” type was selected to observe the Inter class reliability whereas the mean of multiple measurements type was used to observe the Intra class reliability. However, the selection of the ICC definition was based on absolute agreement. The probability value $p \leq 0.05$ was considered significant while $p \leq 0.01$ and above were considered highly/strongly significant.

In the present study, results suggest that pectoralis minor length, forward shoulder posture, and posterior capsular tightness clinical test measurement demonstrated excellent Test-retest reliability on right and left sides (ICC range-0.967 - 0.998); however poor Inter-tester reliability was observed (ICC range-0.291- 0.633). Systematic review by may [17] suggested intra-tester reliability value for Pectoralis Minor length as 0.90-0.93; for horizontal adduction test (posterior capsular tightness) as 0.92 and these values were in agreement to result found in the present study. Contrastingly for Test-retest reliability review suggested ICC values of 0.90-0.93 & 0.88-0.94 pectoralis minor length and forward shoulder posture, however for the horizontal adduction test (posterior capsular tightness) test-retest reliability values were poor (ICC-0.38)

Similarly, Test-retest reliability for cervical range of motion (flexion, extension, lateral flexion (right & left), rotation (right & left) yielded good to excellent results but Inter-tester results findings suggested poor (flexion ROM ICC-0.281; extension ROM ICC-0.619; right & left Lateral flexion ROM= ICC right-0.091; I ICC left- 0.365) to moderate reliability (right & left Rotation ROM=ICC right-739; ICC left-0.615) Systemic review done by Farooq[18] suggested intra tester reliability values (0.83 to .093) for active cervical range of motion were in agreement to result found in present study.

Muscle strength test using sphygmomanometer showed excellent test-retest reliability (ICC flexion Rt & Lt-0.986; ICC Extension Rt & Lt-0.983 & 0.995; ICC Abd Rt & Lt – 0.975 & 0.979; ICC Int Rot Rt & Lt-0.984 & 0.988; ICC Er Rt & Lt-0.994 & 0.997) for shoulder flexors/extensor/abductors/Internal & external rotator strength. However Inter-tester reliability results demonstrated poor ICC values. Contrarily, Inter-tester reliability results demonstrated moderate correlation coefficient (ICC range=0.608-0.796) for lateral scapular slide test both right & left sides (in position I, II &III) along with excellent Test-retest reliability (ICC range=0.969-0.997) Systemic review done by Odom [19] suggested intra tester reliability values (0.75 to 0.80) for lateral scapular slide test were in close agreement to results found in present study.

Although clinical tests used for measuring shoulder girdle positional fault were performed using standardized methods and emphasis was laid on familiarisation of testers but variability in inter-tester reliability values was obvious. The possible reason could be that test measurements were taken during field testing and different factors/sources resulting in variation at the time of recording can't be controlled such as distractions due to inherent noises (college campus) in test areas. For optimal readings focus should be laid on conducting familiarisation of different testers in different environments/sets ups and distractions should be minimized. Further standardization of test procedure along with its interpretation should be minimized. Further standardization of test procedure along with its interpretation should be focused on to minimize bias. Inter-Tester results showed poor reliability of shoulder muscle strength which can be attributed to the limitation that standardization of force exerted by tester on sphygmomanometer cuff while assessing isometric strength was not done.

Excellent Test-retest reliability values for all clinical tests conducted have reinforced the practice of clinical testing one-to-one assessment by a single tester to reduce the chances of variability in test results.

Conclusion

Intra- -tester reliabilities of pectoralis minor length index, forward shoulder posture, posterior capsular tightness, cervical range of motion, shoulder muscle strength, and lateral scapular slide tests were found to be excellent and acceptable for clinical use. But Inter reliabilities values for the above clinical test were found to be poor to moderate in range. Although study results suggested a lack of uniformity in Test-retest and Inter-tester reliability for assessing shoulder girdle posture but future research can be conducted on forming a clinical model based on not only clinical testing but also on patient clinical characteristics as well as environmental or workplace influences to detect abnormality and implicate management.

Acknowledgment

I would like to acknowledge and express my special gratitude to my Guide Dr. Pragya Kumar and co-guide Dr. Raju K Parasher, who gave me this opportunity to conduct the research work.

Reference

1 Ludewig PM, Reynolds JF. The association of scapular kinematics and glenohumeral joint pathologies. journal of orthopedic & sports physical therapy. 2009;39(2):90-104.
2 Lynch SS, Thigpen CA, Mihalik JP, Prentice WE, Padua D. The effects of an exercise intervention on forward head and rounded shoulder postures in elite swimmers. British journal of sports medicine. 2010;44(5):376-81.
3 Borstad JD. Resting position variables at the shoulder: evidence to support a posture-impairment association. Physical Therapy. 2006;86(4):549-57.
4 Sahrmann S. Concepts and principles of movement. Diagnosis and treatment of movement impairment syndromes. 2001.
5 Ludewig PM, Cook TM. Alterations in shoulder kinematics and associated muscle activity in people with symptoms of shoulder impingement. Physical therapy. 2000;80(3):276-91.
6 Griegel-Morris P, Larson K, Mueller-Klaus K, Oatis CA. Incidence of common postural abnormalities in the cervical, shoulder, and thoracic regions and their association with pain in two age groups of healthy subjects. Physical therapy. 1992;72(6):425-31.
7 Kibler BW, Sciascia A, Wilkes T. Scapular dyskinesis and its relation to shoulder injury. JAAOS-journal of the American academy of orthopaedic surgeons. 2012;20(6):364-72.
8 Rosa DP, Borstad JD, Pires ED, Camargo PR. Reliability of measuring pectoralis minor muscle resting length in subjects with and without signs of shoulder impingement. Brazilian journal of physical therapy. 2016;20:176-83.

9 Kibler WB, Ludewig PM, McClure PW, Michener LA, Bak K, Sciascia AD. Clinical implications of scapular dyskinesis in shoulder injury: the 2013 consensus statement from the 'Scapular Summit'. British journal of sports medicine. 2013;47(14):877-85.
10 Laudner KG, Moline MT, Meister K. The relationship between forward scapular posture and posterior shoulder tightness among baseball players. The American journal of sports medicine. 2010;38(10):2106-12..
11 Lewis JS, Valentine RE. The pectoralis minor length test: a study of the intra-rater reliability and diagnostic accuracy in subjects with and without shoulder symptoms. BMC musculoskeletal disorders. 2007;8(1):1-0.
12 Chaves TC, Nagamine HM, Belli JF, De Hannai MC, Bevilaqua-Grossi D, De Oliveira AS. Reliability of fleximetry and goniometry for assessing cervical range of motion among children. Brazilian Journal of Physical Therapy. 2008;12(4):283-9.
13 Toohey LA, Noronha MD, Nunes GS. The use of a sphygmomanometer to measure shoulder isometric strength: a validity and reliability study. Fisioterapia em Movimento. 2017;30:587-93.
14 Taherdoost H. Validity and Reliability of the Research Instrument; How to Test the Validation of a Questionnaire/Survey in a Research SSRN Electron.
15 Ozunlu N, Tekeli H, Baltaci G. Lateral scapular slide test and scapular mobility in volleyball players. Journal of athletic training. 2011;46(4):438-44.
16 Suryasa, I. W., Rodríguez-Gámez, M., & Koldoris, T. (2021). The COVID-19 pandemic. International Journal of Health Sciences, 5(2), vi-ix. https://doi.org/10.53730/ijhs.v5n2.2937
17 Koo TK, Li MY. Cracking the code: providing insight into the fundamentals of research and evidence-based practice a guideline of selecting and reporting intraclass correlation coefficients for reliability research. Journal of Chiropractic Medicine. 2016;15(2):155-63.
18 May S, Chance-Larsen K, Littlewood C, Lomas D, Saad M. Reliability of physical examination tests used in the assessment of patients with shoulder problems: a systematic review. Physiotherapy. 2010;96(3):179-90.
19 Farooq MN, Bandpei MA, Ali M, Khan GA. Reliability of the universal goniometer for assessing active cervical range of motion in asymptomatic healthy persons. Pakistan journal of medical sciences. 2016;32(2):457.
20 Odom CJ, Taylor AB, Hurd CE, Denegar CR. Measurement of scapular asymmetry and assessment of shoulder dysfunction using the lateral scapular slide test: a reliability and validity study. Physical therapy. 2001;81(2):799-809..