What is normal isokinetic shoulder strength or strength ratios? A systematic review

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Abstract. Purpose: To systematically review the literature regarding isokinetic testing to identify values for isokinetic shoulder strength and agonist/antagonist ratios in the general population which may be used as reference values when assessing, planning and implementing shoulder rehabilitation.

Methods: Electronic databases were systematically searched and reference lists of all retrieved papers were hand searched and nine relevant studies were identified. Two independent reviewers assessed methodological quality and extracted data.

Results: Seven studies reported the effect of limb dominance on strength with four reporting no significant difference between the dominant and non-dominant limbs. The studies which compared muscle strength with gender concluded that men were significantly stronger than women at all speeds in all directions. Age was reported to have no significant effect on muscle strength.

Four studies agreed that adduction and extension muscle strength were greater than other directions and flexion, abduction, internal rotation and external rotation were the next strongest in that order.

Conclusions: Nine low and moderate quality research papers have attempted to establish isokinetic shoulder strength in a general population. Poor consistency with respect to sample sizes, randomization and selection of testing velocities and positions did not allow direct comparison of the results. Future research involving symptomatic subjects will need to be matched to a group of subjects from the general population of the same age, gender and physical profile with adequate sample sizes representative of the symptomatic population.

Keywords: Isokinetic, shoulder strength, strength ratios

1. Introduction

1.1. Background

Muscle strength is commonly assessed and reassessed for diagnostic purposes and to assess the outcome of therapeutic interventions and rehabilitation. Three methods used for performing muscle strength assessment are manual muscle testing (MMT), hand held dynamometry and isokinetic dynamometry. MMT is widely used for assessment of muscle strength in the clinical setting as it is cheap and easy to perform. A number of MMT protocols are in wide clinical use but all use similar criteria to assign grades based on the ability of the muscles to contract through range and against gravity or manual resistance [1,2]. MMT has limited usefulness as a tool for assessing the response to therapeutic interventions as it is not sufficiently sensitive or reliable to detect subtle weakness or small changes in strength [3–5]. Hand held dynamometry is popular for its portability and has been shown to be highly reliable in measuring isometric strength but it is not clear how well inferences can be made from tests of this type to the ability of muscle to generate tension for task performance [6]. It has been shown to be influenced by the testers force generating capacity [5, 7]. Isokinetic dynamometers enable measurement of muscle torque production during the performance of a
constant-velocity movement. Studies of most isokinetic devices have shown that the measurements obtained from them have good test reliability, particularly after proper patient instruction and familiarization with the equipment and testing procedure [8–11].

In summary, strength values obtained using isokinetic dynamometry in a clinical setting are considered the most reliable, valid and safe strength measurements used by therapists, when compared with MMT and hand held dynamometry, even when recorded by different therapists and with different subjects.

1.2. Rationale and review question

Judgments about the extent of impairment require comparison with some reference value. A common reference used are normative values [7]. Normative values assist clinicians to establish rehabilitation programs following specific surgical procedures, general injury and dysfunction. Establishment of normative strength values allows strength to be assessed relative to a matched population and to assess strength deficits relative to the individuals own strength [12]. Extensive isokinetic testing has been performed on knee flexion and extension with ‘normal values’ rated as the unaffected limb based on the assumption that the muscle torque of both lower limbs are equal [13]. Discussion continues in the literature as to the value of comparing asymptomatic upper limb isokinetic strength values to symptomatic upper limb strength values. Arm dominance and regular participation in physical activities favouring one limb may result in significant isokinetic strength differences between limbs with bilateral involvement also presenting difficulties in comparison [6, 11]. Another reference value used for comparison are unilateral isokinetic strength ratios between the agonist and antagonist muscles used to identify particular weaknesses in a muscle group [11].

This systematic review was undertaken to identify values for isokinetic shoulder strength and agonist/antagonist ratios in the general population which may be used as reference values when assessing, planning and implementing shoulder rehabilitation.

2. Method

2.1. Identification and selection of studies

Ovid Medline was searched by the reviewer for studies published between 1950 to week 1 of March 2010. Although this initial date falls outside the commencement of isokinetic research it was the only default parameter available for selection which ensured early research would be captured. Additional searches were performed in Cinahl, The Cochrane library, PEDro, sportDiscus and Google. The search strategy included:

1. Isokinetic
2. Strength testing
3. Shoulder or glenohumeral
4. 2 and 3
5. 1 and 4
6. Dynamometer
7. Cybex
8. Kin-Com or kincom or kinetic communicator
9. 6 or 7 or 8
10. 5 and 9

Reference lists of all retrieved papers were hand searched for relevant studies. This was performed by one reviewer (HL).

2.2. Inclusion criteria

Any journal article that referred to shoulder isokinetic strength testing was included in the review.

2.3. Exclusion criteria

Articles with no statistical analysis were excluded. Populations with specific pathologies such as cystic fibrosis, paraplegia or with painful shoulder conditions such as impingement were excluded along with specific studies investigating post-shoulder surgery. Studies which exclusively reviewed isokinetic strength of glenohumeral internal and external rotators were excluded as these would not provide an indication of overall shoulder strength. Specific populations exclusively assessed such as baseball pitchers were also excluded. Papers that contained no data and book chapters were also excluded from the review. The search was limited to humans and to studies published in English.

2.4. Data extraction

The results of the electronic database search are detailed in Fig. 1.

The included studies are summarized in Table 1. The variables extracted from these studies have been detailed in the results and include:
Table 1
Summary of included studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Subjects</th>
<th>Limb dominance and Incl/Excl criteria</th>
<th>Brand of isokinetic dynamometer</th>
<th>Test position</th>
<th>Test protocol</th>
<th>Statistics used</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cahalan et al. (1991) [3]</td>
<td>50 healthy, adult volunteers 21–40 yrs 26 men and 24 women</td>
<td>Not detailed</td>
<td>Cybex II</td>
<td>Flex in sagittal plane</td>
<td>Test side randomised.</td>
<td>Paired t-test to determine differences in strength as a factor of dominance. Two sample test to test significance related to gender.</td>
<td>Mean peak torque values generally decreased as speed increased. Men significantly stronger than women for all motions &amp; speeds tested. Shoulder extension torque was greatest followed by adduction, flexion, IR, abduction and ER. Torque production tended to be greater on the dominant side.</td>
</tr>
<tr>
<td>Chi-hung So et al. (1995) [19]</td>
<td>30 normal, healthy volunteers Mean age 21 yrs ± 2.3 yrs All male</td>
<td>Dominance not detailed Subjects had no shoulder pain or injury at the time of the study.</td>
<td>Cybex II with U.B.X.T. (upper body exercise and testing table).</td>
<td>Supine</td>
<td>The two muscle groups were randomised. Gravity correction applied. Velocities: 60 and 240 deg/sec.</td>
<td>Paired t-tests: to test for bilateral differences set at two tailed (p &lt; 0.01). Correlation used to determine the linear relationship between dominant and non-dom for the same measurement.</td>
<td>Significant bilateral differences. Concluded &quot;it would be inappropriate to use uninjured limb for comparison.&quot;</td>
</tr>
<tr>
<td>Connolly Maddux et al. (1989) [17]</td>
<td>Different subjects for IR/ER and Mod Abd/Add Max. 40 subjects 21 males 34 yrs ± 10 yrs 19 females 21 yrs ± 6 yrs 79% Males 47% Fem exercised regularly</td>
<td>16 right handed males 17 right handed females No history of shoulder pain/ injury at the time of testing. 10 subjects reported injury &gt; 12 months previous. 2 excluded: 2 females insuff torque &amp; 1 male discomfort</td>
<td>Cybex II isokinetic with U.B.X.T. (upper body exercise and testing table).</td>
<td>IR/ER supine with shoulder at 90 deg abd through range of 180 deg. Modified Abd/Add seated reclined through range of 90 deg. No warmup described.</td>
<td>Not reported if gravity adjusted or randomised. Velocities: 60 and 180 deg/sec. Used skinfold calipers.</td>
<td>Means and SD: determined for peak torques &amp; normalised for weight/lean body mass. Paired t-tests (p &lt; 0.05): for differences between dom and non-dom. Independent t-test (p &lt; 0.05): for differences between males and females &amp; when normalised for body weight the peak torque between sexes for dom &amp; non-dom. Pearson product correlation coefficient: for the angle of peak torque between dom &amp; non-dom</td>
<td>No significant difference in peak torques between dom &amp; non-dom. A significant difference was found between sexes for peak torque, total work and power. No difference when comparing agonist/antagonist peak torque and work values. Large SD's.</td>
</tr>
<tr>
<td>Ivey et al. (1985) [15]</td>
<td>31 volunteers 21 to 50 yrs Av. 27 yrs. 18 males 13 females 12 = no upper limb exercise 12 = regular exercise 7 = occ. exer</td>
<td>24 subjects were right dominant</td>
<td>Cybex II with U.B.X.T. (upper body exercise and testing table).</td>
<td>Supine. Abd/Add</td>
<td>Not detailed if randomised or gravity compensated. Suggest unlikely. Velocities: 60 and 180 deg/sec.</td>
<td>Specific tests used not detailed. Described that the average and SD for the group as a whole and then the sub-groups were analysed. Also analysed for correlation with variables and variance.</td>
<td>Descending order of muscle strength for both genders was: Add, Ext, Fl, Abd, IR. ER Ratios: IR-ER (3:2) Add-abd (2:1) Exo-Fl (5:4) Age and dominance had no general effect</td>
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</table>
Table 1, continued

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<tr>
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<tr>
<td>Kuhlman et al. (1992)</td>
<td>39 subjects in 3 groups: 1. 19–30 yrs (av. 24 yrs) males = 21 subjects. All participated regularly in athletics. 2. 51–65 yrs (av. 58 yrs) males = 9 subjects. 3. 50–65 yrs (av. 56 yrs) females = 9 subjects.</td>
<td>All right handed. No history of major trouble with the shoulder. No asymptomatic function of the shoulder and no previous injury or treatment to the upper extremity or neck. 2 were excluded due to a history of problems with shoulder.</td>
<td>Lido 2.0</td>
<td>ER = supine with shoulder in scapula plane. Abd = seated, in scapula plane. Range: 120 deg. Grasped handle. Warmup on machine only. Well stabilised.</td>
<td>Not detailed if randomised or gravity compensation used. Velocities: 90 and 120 deg/sec.</td>
<td>Average peak torque produced by each subject was used as the value of isokinetic peak torque. Average values were used for work angle at which peak torque was produced. 2 way ANOVA with each test group (by age and sex) and mode of testing at each speed.</td>
<td>All subjects tolerated testing in the plane of the scapula without discomfort. Isokinetic peak torque was greater at 90 deg/sec. Repeat testing demonstrated high reliability at angles within range of production of peak torque.</td>
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<td>Perrin et al. (1987)</td>
<td>45 subjects: 18 to 27 yrs (av. 19 yrs) All males. 15 intercollegiate baseball pitchers. 15 intercollegiate swimmers. 15 non-athletic college students</td>
<td>All right handed. Subjects were medically screened for previous injury to knee or shoulder.</td>
<td>Cybex II with U.B.X.T. (upper body exercise and testing table).</td>
<td>Supine. Shoulder at 90 degrees for IR/ER and from 0–165 for ext/fl. Also tested the knee. Warmup.</td>
<td>No gravity correction for shoulder assessment. Velocities: 60 and 180 deg/sec. Concentric. Order of muscle groups tested randomised. Order of side to be tested was restricted randomised.</td>
<td>12 2 way ANOVA computed for measures at both 60 and 180deg/sec. Peak torque identified at both speeds.</td>
<td>No significant difference in peak torque found between right and left sides for shoulder IR/ER and Fl. Right &gt; left (p &lt; 0.05) for shoulder ext at both speeds. Bilateral differences approached 10% for pitchers and within 5% for swimmers and non-athletes.</td>
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<td>Reid et al. (1989) [20]</td>
<td>40 subjects described as ‘moderately fit athletic individuals with a variety of sporting backgrounds’ 15–36 yrs (Av. 25 yrs) = 20 males 19–34 yrs (Av. 27 yrs) = 20 females</td>
<td>16 males right handed. All females right handed Subjects had no shoulder pain or dislocations</td>
<td>Cybex II with U.B.X.T. (upper body exercise and testing table).</td>
<td>Abd/Add in reclined sitting through 0 to 180 deg. IR/ER in supine at 90 deg IR/ER in standing Range: 180 deg</td>
<td>No gravity correction reported. Velocity: 60 deg/sec No randomisation reported.</td>
<td>Concentric</td>
<td>Comparison of selected means using independent t-test for comparison between sexes and dependent t-test for comparisons within a sex. Non-directional 5% significance level Ratios: Add &gt; abd IR &gt; ER Men twice as strong as women in this population. No differences in means for dom &amp; non-dom within a sex. No difference in peak torque of IR/ER in standing and lying</td>
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<tr>
<td>Shklar &amp; Dvir (1995) [18]</td>
<td>30 Healthy Volunteers 22–35 years 15 males 15 females</td>
<td>Limb Dominance Not detailed Subjects were without history of shoulder pathology established through interview and general physical examination following the Maitland protocol</td>
<td>Kin-Com II</td>
<td>Seated. Abd/Add – elbow extension and forearm pronated. FFEExt – forearm in mid-position. IR/ER – scapular plane, supported at elbow Range: 120 deg Warm-up Well stabilised</td>
<td>Order of testing randomised. Within same muscle group, order of velocity randomised. Velocities: 60, 120 and 180 deg/sec Gravity correction applied.</td>
<td>Concentric and Eccentric</td>
<td>No statistical analysis performed. Analysis using kin-com software only. Descending order of muscle strength at both contraction modes and for both genders was: extensors, adductors, flexors, abductors, IR’s and ER’s. Strength correlation co-efficients have indicated significant. Moderate-fairly strong relationships in men but not women.</td>
</tr>
</tbody>
</table>
Sample characteristics including size, age, gender, health status, activity level, limb dominance and inclusion/exclusion criteria
– Isokinetic instrumentation including the model used and the range of motion and velocities used for testing
– The purpose and findings of each of the studies

3. Description of studies/results

Nine studies met the inclusion criteria of this search. All studies were stand alone projects. A description of each of the reviewed studies is presented alphabetically in Table 1.

All studies identified were rated as level 4 and level 5 evidence according to the categorization described by the Oxford Centre for Evidence Based Medicine [14].

A published specific rating scale for evaluation of isokinetic studies was not identified. The author designed a quality rating procedure based on modification of a generic evaluation tool developed by the Cochrane Group (Table 2). Full text articles were rated by the two independent reviewers (SG and HL) using the ten question rating procedure. When they felt the question was dealt with extensively in the paper it received a rating of two, when it was briefly mentioned it received a rating of one and when not mentioned or adequate details were not available a rating of zero was given.

Studies were considered of high quality if they received a quality score of 16 or higher, of moderate quality if they scored between 12 and 16, and of low quality if they scored 12 or less. As seen in Table 3, four papers were rated as moderate quality and five as low quality.

There was an 8% disagreement between the reviewers. There was complete agreement on questions five, eight and nine. Differences between raters related to consideration of gravity compensation and the references in the remaining papers being appropriate and comprehensive at the time the paper was written. Consensus was achieved by the reviewers through discussion and the results were tabulated (Table 3).

3.1. Sample size

Seven of the nine studies reviewed considered strength measurements of the general population yet the age and gender of the participants were not representative of this. Studies included very few female participants and the majority of participants were aged between 18 and 40 years. Sample sizes averaged 30 to 45 subjects which did not allow effective statistical power to provide convincing or generalisable data.

3.2. Age and gender

Two of the studies included subjects over 40 years of age. One study included a wide age range (21 to 50
years) which was used in the statistical analysis [15]. This study did not report the exact number of subjects used for calculations involving age. As the sample size was already inadequate the number of older subjects must be assumed to be very small. Another used nine males and nine females over 50 years but did not use age as a separate factor in the statistical analysis [16]. Sex was used in the statistical analysis which implies a sampling error as only nine of the 39 subjects were females.

Two of the studies concluded men were significantly stronger than women for all motions and speeds tested [3,17]. Another reported age had no general effect [15]. One found fairly strong relationships in men but not in women [18].

3.3. Description of participants

3.3.1. Health status and activity level

Subjects were described as “normal, healthy volunteers” in three studies [12,18,19]. General activity level of the subjects was not controlled for in three of the studies [15,17,20] or not detailed at all in four of the studies. Activity level descriptions varied: “12 participants did no upper extremity exercise; seven exercised occasionally and 12 exercised regularly” [15]. “Moderately fit athletic individuals from a variety of sporting backgrounds” [20]. “None participated in recreational sports regularly” [16]. This variance in regular muscular activity is likely to affect the internal validity of these studies. Strength measurements recorded may have been affected by the regular participation in upper body exercise rather than just being influenced by dominance, gender or age. Only one study chose to group participants according to their athletic activity: college baseball pitchers, swimmers and non-athletes [21].

3.3.2. Limb dominance

Some studies did not detail the limb dominance of participants [3,19] others included only right handed participants [16,21] which contributed to sample bias.

A representative sample with 10% left hand dominant participants was achieved in one of the studies [17]. Another included a sufficient number of right and left hand participants but did not detail the number of male and female [15]. Another used 36 males of which 34 were right handed [12]. Using this assumption, they should have had four left hand dominant subjects.

Seven of the studies reported the effect of limb dominance. Four of these reported no significant difference between the dominant and non-dominant limbs [12,15,17,20]. Only one reported a significant difference in peak torque between dominant and non-dominant limbs for extension [21]. However, they identified bilateral strength differences of up to 10% for pitchers and 5% for swimmers and non-athletes. One reported significant bilateral strength differences in shoulder flexion and extension [19] whereas another commented that torque production tended to be greater on the dominant side [3].

3.4. Inclusion and exclusion criteria

The current condition of subjects’ shoulders was not clearly described in all reviewed studies. Overall, the studies included subjects with full active shoulder range of motion who reported they were currently asymptomatic. However, clear differentiation between those with shoulder instability or laxity was not provided.

Only two studies provided a description of subjects who were excluded from their studies [16,17].
3.5. Purpose of study

The purpose of the studies was not homogeneous. Three studies aimed to obtain normal values of isokinetic strength of shoulder Flexion/Extension (Fl/Ext); Abduction/Adduction (Abd/Add) and Internal Rotation (IR)/External Rotation (ER) [3,15,18]. One aimed to establish normal values of Abd/Add and IR/ER [20]. Another tested shoulder Fl and Ext [19]. Both these studies aimed to collate normal values for the populations tested and then develop a method/model for determining the strength of the opposite limb [19,20].

3.6. Range of motion tested

The total range of motion (ROM) through which the limb was tested was not consistent between studies. Two studies have not detailed the range through which testing was conducted [3,19]. Ranges used for testing varied from 120 degrees [16,18], 180 degrees [15,20], 165 degrees [21] and 135 degrees [12].

3.7. Positions for testing and equipment used

Three different types of isokinetic dynamometer were used in the studies. Six of the studies used Cybex II with the upper limb exercise table. This machine is defined as a passive machine as it offers resistance exclusively to concentric muscle work [8, p. 240]. It requires testing of shoulder IR and ER to be performed in supine and Abd in the reclined seated position. One study used the Kin-Com [18] which measures concentric and eccentric muscle activity in a sitting position. The third machine used was the Lido [16] which measured concentric isokinetic and isometric muscle force. Abd was tested in sitting and ER in supine.

The studies using a seated test position have used the scapula plane as a test position [18], for IR/ER [3], for Abd/Add [16], for Abd [17], for modified Abd/Add. The test position has been standardised in each investigation however there is wide variation between studies. This prevents meaningful comparison between their outcomes.

Reliability and validity for the Cybex II and the Kin-Com have been established. Face validity can be assumed for both these devices assuming they are regularly maintained and gravity compensation has been applied when testing. However, only three of the studies reviewed reported using gravity compensation [12, 18,19].

3.8. Velocity

No apparent consistency was used when choosing velocities. As can be seen in Table 1, 60°/s was used in all but one of the studies where the velocity was detailed. The remaining velocities varied between 90°/s, 120°/s, 180°/s, 210°/s, 240°/s and 300°/s. One study [20] chose to do testing at only 60°/s, another only at 48°/s [12] with all other studies using two or more velocities.

3.9. Findings

Four of the studies reported on the descending order of muscle strength according to the direction of movement as Fl, Abd, IR followed by ER [12,15,18]. Ext and Add were included in some of the studies in which the order of strength varied [3,15,18]. This inconsistency may be due to the variation in factors discussed previously.

Three of the studies reported their purpose was to collect normal isokinetic values, thereby creating a normal strength database which may become a reference [3,15, 20]. Reviewing the strength results obtained showed wide variance. However a comparison could be made with three studies which tested younger males at a velocity of 60°/s through shoulder Fl and Ext [3,18,19]. On reviewing these results normal concentric shoulder Fl peak torque in this group is about 50 Nm and Ext 85 Nm on the dominant side. (Fl results were 47.5, SD 7.9; 50, SD 12; 61.2, SD 13.3 and Ext results were 66.7, SD 12.9; 87 SD 18; 84.9, SD 20.5).

Comparison was made with four studies which tested young males and females at a velocity of 60°/s through shoulder Abd and Add [3,17,18,20]. Normal concentric shoulder Abd peak torque on the dominant side in this group for males is about 45 Nm and Add 65 Nm. (Abd results were 39,SD19; 50,SD14; 39,SD9; 50.5,SD13 and Add results were 63,SD14; 86, SD19; 80,SD 16; 72.9, SD19.6). Normal concentric shoulder Abd peak torque on the dominant side in this group for females is about 23 Nm and adduction 38 Nm. (Abduction results were 19,SD4; 23,SD5; 20,SD4; 28.4,SD4.6 and Add results were 32,SD7; 46,SD 9; 39,SD6; 32.4, SD6.9).

Gravity correction was not applied in each of these studies which affects the comparison of this data.

4. Discussion

The limited quality of research available regarding isokinetic shoulder strength and agonist/antagonist ra-
Conformity between the humeral head and the glenoid, and more comfort during testing [16, p. 1320]. The opposing view to this is that “although there may be issues of stability and comfort that are optimized by measuring strength of the shoulder in the plane of the scapula, there is no support at the present time for the notion that this position enhances strength complexities affecting muscle performance.” [26]. It could be argued that functionally both Fl/Ext and Abd/Add are performed outside the scapula plane. However, any investigation which seeks to establish normal strength values must standardize the test position.

Considering these findings, limited comparisons in strength of the same muscle group can be made when the testing position is not identical. However, three studies have attempted to directly compare their results despite significant variation in the test positions used. Ivey et al. tested in a supine testing position, through 180 degrees, with IR/ER tested at 90 degrees of Abd [15]. Cahalan et al. used a seated testing position with Fl/Ext in the sagittal plane, Abd/Add in the plane of the scapula and IR/ER in the transverse plane but only at 15 degrees Abd [3]. Shklar and Dvir tested in sitting but IR/ER was tested in the scapular plane [18]. The effects of gravity differ between supine lying and sitting. When relating results to function, sitting provides a more functional test position than supine lying.

Comparison of isokinetic strength data measured on different isokinetic dynamometers is not recommended. Significant differences have been obtained for testing measurements of the same variable with the same subjects using different devices [27,28].

The need to include gravity correction in dynamometric measurements continues to be argued in the literature. It has been shown that applying the gravitational procedure when testing shoulder IR and ER strength has a significant influence. When not corrected the IR strength is significantly lower and ER significantly higher [29]. When testing trunk isokinetics significant error was found when the gravity correction procedure was applied due to the inability of the subjects to completely relax [30]. The torque registered by the dynamometer is not actual muscular torque but the resultant of muscular and gravitational forces. The influence of gravity varies throughout the range of testing being performed. This potential for error suggests direct comparisons should only be made between values obtained using the same testing procedure.

Contraction velocity and level of fibre recruitment alter measured muscle strength [26]. Hence using two or more velocities with at least one being slow and the
other fast, would assist in establishing overall strength performance. No standardization of velocity between the studies is evident. No reasoning is provided to support the choice of certain velocities. It has been reported that peak torques decrease as testing velocity increases from 60°/s through 180°/s to 300°/s [31]. When muscles contract at a higher velocity they do not have the time to develop maximal tension. At faster velocities, a greater range of movement is needed to give the limb time to catch up to the speed of the dynamometer [8, p. 244]. It has been suggested velocities above 180°/s are not to be considered isokinetic due to the range of motion needed to obtain an isokinetic movement. At 300°/s a range of 60° is needed [6]. In summary, differing velocities and differing positions will result in different measures of isokinetic strength. Comparison between research findings should only be made when assessed in the same position and at the same velocity. Currently there are no reports which have identified the velocity of shoulder motion for normal activities of daily living. The velocity of testing should be matched to the velocity of functional activities so that the strength measurements are applicable to functional rehabilitation outcomes.

During isokinetic concentric shoulder elevation in the coronal and sagittal planes it has been reported that the centre of rotation of the glenohumeral joint was displaced 8 cm vertically relative to the centre of rotation of the dynamometer’s actuator arm [32]. The effect of isokinetic velocity on this displacement was not significant. The authors attributed this effect to normal kinematics of shoulder elevation that requires synchronous function of both the scapulothoracic and glenohumeral joints. Therefore, when testing isokinetic strength standardization of both scapula and glenohumeral joint position must be ensured.

The studies reviewed primarily investigated strength measurements in participants under the age of 40 years, with two of the studies including participants up to 50 years. It is unknown whether this was due to participant availability or to exclusion due to current or past history or symptoms. The presence of rotator cuff degeneration and tears are known to be more prevalent in the older population and may alter strength measurements. A recent study revealed a high prevalence of rotator cuff tears in elderly asymptomatic individuals using ultrasonography [33]. They concluded studies establishing normative values for isometric shoulder strength may have been skewed by the presence of asymptomatic rotator cuff tears in elderly subgroups. The same should be considered when undertaking isokinetic testing. However, a large number of older people present for rehabilitation with shoulder dysfunction and establishing data for strength in all age groups is needed to assist in the assessment and rehabilitation of shoulder dysfunction.

Since the completion of this systematic review, a large study with 438 participants has recently been published producing isokinetic normative values for the ankle, knee, shoulder and forearm in a subset of the normal population group. The specific cohort included fit South African males aged between 16 to 20 yrs (average 19 yrs) who were applying to become pilots in the airforce. Testing of the non-dominant side was performed on a Cybex, concentrically at 60°/sec without gravity correction. Shoulder tests, performed in supine consisted of flexion, extension, horizontal abduction and adduction and internal and external rotation. The shoulder results varied when compared to previous studies most likely due to the variability in sample size, population and testing procedures used. The data generated from this study may be useful for clinical evaluations within this group [29].

5. Summary

This systematic review identified nine low and moderate quality research papers which have attempted to establish isokinetic shoulder strength in the general population. Poor consistency with respect to selection of testing velocities and positions did not allow direct comparison of the results.

Future research involving symptomatic subjects will need to be matched to a group of subjects from the general population of the same age, gender and physical profile with adequate sample sizes representative of the symptomatic population. The velocities tested should be based on functional activities and in functional positions, with standardized glenohumeral and scapulothoracic positions.

References


