



Test-Retest Reliability of the Closed Kinetic Chain Upper Extremity Stability Test in Gymnasts With and Without Upper Limb Pain

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BACKGROUND

- Gymnastics requires significant muscular activity of the upper extremity in a closed kinetic chain position.^{1,2}
- Gymnasts have a high injury rate, with 30% of all injuries occurring in the upper extremity.^{3,4} For physical therapists, sports-specific physical performance tests would benefit in the clinical decision process to return these athletes to gymnastics after upper limb injury.
- While the Closed Kinetic Chain Upper Extremity Stability Test (CKCUEST) has established reliability for other populations,^{5,6} evidence is limited in the female gymnastics' population in those with and without upper limb pain.

OBJECTIVES

- The purpose of this study is to determine between day test-retest reliability of the CKCUEST in female competitive gymnasts with and without upper limb pain.
- It is hypothesized the CKCUEST will have excellent test-retest reliability in this population.

METHODS

- The CKCUEST was performed on a flat, firm surface.
- To account for limb length differences, individuals began in a modified testing position with their hands directly underneath their shoulders (see Figure 1A).⁷
- The participant alternated touching two marks (see Figure 1B), 36 inches apart, for 15 seconds, followed by resting for 45 seconds.⁸ Three trials were performed.⁸
- A final score was calculated using the mean number of touches recorded over the three trials.^{8,9} Scores were normalized to the participant's upper limb length.⁷ For between-day reliability assessment, gymnasts performed the CKCUEST during a follow up testing session one week later.
- Intraclass correlation (ICC_{3,1}) was used to compare scores across test days, using a two-way random effects model with absolute agreement and "average" unit.

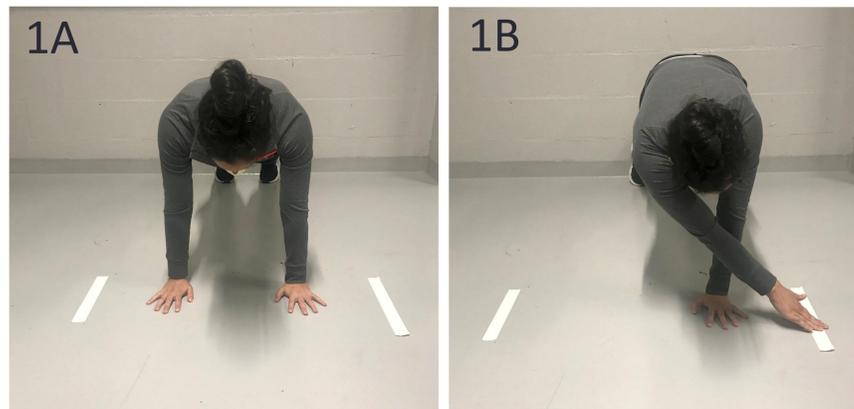


Figure 1: Modified positioning for performing the CKCUEST. Starting position (1A) and execution of touch (1B).

TABLE 1. PARTICIPANT DEMOGRAPHICS

Study Participants	
Average Age in Years (SD)	13.8 (2.3)
Min, Max	9.7, 18.3
% (N) by Level	
6	17% (3)
7	50% (9)
8	6% (1)
9	17% (3)
10	11% (2)
Average BMI (SD)	21.3 (2.1)
Min, Max	18.7, 25.5
Average Upper Limb Length, cm (SD)	82.2 (3.8)
Min, Max	75, 91
% (N) in Pain Group	44% (8)

* In female gymnastics, the level of competition ranges from Level 0 to 10, then terminates with the elite level.

TABLE 2. CKCUEST SCORES BY TEST DAY

	Test – Day 1	Retest - Day 7
Mean number of hand touches (SD)	26.6 (4.5)	27.8 (4.6)
Min, Max	18.3, 35.7	18.3, 36.9
Median (IQR)	27.0 (23.0, 28.5)	28.3 (25.1, 29.9)

All scores calculated are normalized for upper extremity limb length.

RESULTS

- 18 female gymnasts (mean age of 13.8 years) participating in Level 6 gymnastics and higher were recruited for this study from two gymnastics clubs. Of those, 8 reported upper limb pain.
- Results showed **excellent test-retest reliability**, with ICC=0.92, 95% CI=0.74-0.97, p<0.001.

CONCLUSIONS

- The CKCUEST appears to be a safe assessment tool to perform on gymnasts with and without upper limb pain who are currently participating in gymnastics activities.
- Our results indicate that the modified CKCUEST may be a reliable outcome measure to assess upper extremity performance in female competitive gymnasts with and without upper limb pain.

REFERENCES

- Uhl TL, Carver TJ, Mattacola CG, Mair SD, Nitz AJ. Shoulder musculature activation during upper extremity weight-bearing exercise. *J Orthop Sports Phys Ther.* 2003;33(3):109-117. doi:10.2519/jospt.2003.33.3.109
- Davidson PL, Mahar B, Chalmers DJ, Wilson BD. Impact modeling of gymnastic back-handsprings and dive-rolls in children. *J Appl Biomech.* 2005;21(2):115-128. doi:10.1123/jab.21.2.115
- Thomas RE, Thomas BC. A systematic review of injuries in gymnastics. *Phys Sportsmed.* 2019;47(1):96-121. doi:10.1080/00913847.2018.1527646
- Campbell RA, Bradshaw EJ, Ball NB, Pease DL, Spratford W. Injury epidemiology and risk factors in competitive artistic gymnasts: a systematic review. *Br J Sports Med.* 2019;53(17):1056-1069. doi:10.1136/bjsports-2018-099547
- Olds M, Coulter C, Marant D, Uhl T. Reliability of a shoulder arm return to sport test battery. *Phys Ther Sport.* 2019;39:16-22. doi:10.1016/j.ptsp.2019.06.001
- Silva YA, Novaes WA, Dos Passos MHP, et al. Reliability of the Closed Kinetic Chain Upper Extremity Stability Test in young adults. *Phys Ther Sport.* 2019;38:17-22. doi:10.1016/j.ptsp.2019.04.004
- Hollstadt K, Boland M, Mulligan I. Test-Retest Reliability of the Closed Kinetic Chain Upper Extremity Stability Test (CKCUEST) in a Modified Test Position in Division I Collegiate Basketball Players. *Int J Sports Phys Ther.* 2020;15(2):203-209.
- Goldbeck TG, Davies, GJ. Test-retest reliability of the closed kinetic chain upper extremity stability test: A clinical field test. *Journal of Sport Rehabilitation.* 2000;9:35-45. Doi.org/10.1123/jsr.9.1.35.
- Tucci HT, Martins J, Sposito Gde C, Camarini PM, de Oliveira AS. Closed Kinetic Chain Upper Extremity Stability test (CKCUES test): a reliability study in persons with and without shoulder impingement syndrome. *BMC Musculoskelet Disord.* 2014;15:1. Published 2014 Jan 3. doi:10.1186/1471-2474-15-1