

# Neuromuscular Assessment of Collegiate-Level Female Cheerleaders

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**Abstract.** Recent epidemiological data on U.S. cheerleaders suggest that injuries are on the rise and the majority of injuries sustained are strains/sprains of the lower extremities. The purpose of this study was to investigate possible neuromuscular factors contributing to injury rates in collegiate-level cheerleaders. Six female collegiate cheerleaders volunteered for this study. Participants underwent isokinetic muscular strength assessment of the knee flexors and extensors using an Isokinetic Dynamometer. Knee extensors and flexors were tested at a velocity of  $60^{\circ}\cdot\text{s}^{-1}$  for peak torque and analysis of the hamstrings to quadriceps (H:Q) ratio. No differences in quadriceps ( $p=0.371$ ) (right leg:  $111.1 \pm 28.2$  N·m, left leg:  $105.5 \pm 35.8$  N·m) or hamstrings ( $p=0.098$ ) (right:  $62.2 \pm 14.2$  N·m, left:  $56.4 \pm 15.2$  N·m) peak torque were observed between legs. The H:Q ratios were  $0.54 \pm 0.07$  and  $0.53 \pm 0.04$  for right and left legs, respectively. Our results revealed that H:Q ratios in cheerleaders are below the proposed normative value of 0.6. Thus, cheerleaders should increase their focus on conditioning and strength-training of the lower extremities to help avoid thigh- and knee-related injuries.

## 1. Introduction

Cheerleading has developed in the last couple of decades into a competitive sport requiring a high level of fitness. Decades ago, cheerleaders performed basic maneuvers such as toe-touch jumps and the splits. Today cheerleading has developed into a demanding athletic sport that integrates elements of dance, gymnastic tumbling runs and partner stunts that include human pyramids lifts, catches, and basket tosses. Cheerleading is a highly competitive sport that is physically demanding and requires specificity in training as is necessary for other sports. According to recently published epidemiological studies, injury rates in this population are on the rise; with the majority of injuries (30-37%) occurring in the lower extremities [1]. Of these injuries, the most commonly reported are strains/sprains which account for over 50% of all lower extremity injuries [1]. Currently, there are no studies in the literature investigating potential neuromuscular factors related to injuries of this kind in competitive cheerleaders. Therefore, the purpose of this study was to investigate potential lower-limb muscular imbalances that may exist in competitive cheerleaders using the well-defined hamstrings to quadriceps (H:Q) strength ratio.

## 2. Methods, Results, and Discussion

### *Methods*

**Participants.** Six Wichita State University female collegiate cheerleaders volunteered for the study. Participants were notified of all the experimental procedures and potential risks involved. Prior to testing, participants completed a health status questionnaire and an informed consent form. Demographic and anthropometric data including participant's age, height, and weight were gathered. Height (cm) and weight (kg) were determined using a calibrated stadiometer and calibrated clinical weight scale, respectively. The study was approved by Wichita State University's Institutional Review Board.

**Isokinetic Dynamometry.** Participants completed a single bout of maximal knee flexion and extension concentric contractions using an isokinetic dynamometer (BIODEX; System 4 Pro, New York, NY, USA) on both legs. Participants were in an upright seated position with straps securing the trunk, pelvis, and thigh. The input axis of the dynamometer was aligned with the axis of rotation of the knee. Prior to each isokinetic assessment, limb mass was measured with the leg parallel to the floor for gravity correction and each participant's range of motion was individually determined. Three submaximal warm-up trials preceded five maximal muscle contractions at a velocity of 60 degrees/second. Participants were given loud verbal encouragement during the test and instructed to "kick out"

and “pull back” as hard and as fast as possible throughout the entire range of motion. The contraction producing the highest peak torque (N.m) for knee extension and flexion was used to calculate the H:Q ratio.

*Statistical Analysis.* Analyses were performed using SPSS for Windows version 18.0 (Chicago, IL). Data are presented as mean ± standard deviation. Side to side limb comparisons for peak muscle torque was determined using a paired samples t-test. Significance level for mean differences was set at  $p \leq 0.05$ . H:Q ratio was calculated using the following formula: knee flexion peak torque/knee extension peak torque.

*Results*

Subject characteristics are presented below in Table 1. Peak torque and H:Q ratios are presented in Table 2. Peak muscle torque did not differ significantly between right and left legs for either knee extension or flexion ( $p > 0.05$ ). H:Q ratio for the right and left leg was  $0.54 \pm 0.01$  and  $0.53 \pm 0.03$ , respectively.

Table 1. Subject Characteristics

Variable	Cheerleaders (n=6)
Age (yrs)	19.2 ± 1.3
Height (m)	1.61 ± 0.07
Weight (kg)	56.3 ± 5.6
BMI (kg/m <sup>2</sup> )	21.8 ± 1.8
Years Cheerleading	3.7 ± 1.2

Table 2. Isokinetic Peak Muscle Torque and H:Q Ratio

Variable	Right Leg		Left Leg	
	Knee Extension	Knee Flexion	Knee Extension	Knee Flexion
Peak Torque (N.m.)	111.1 ± 28.2	62.2 ± 14.2	105.5 ± 35.8	56.4 ± 15.2
H:Q Ratio	0.54 ± 0.01		0.53 ± 0.03	

*Discussion*

To date, no studies have been conducted on this special population specifically to determine neuromuscular factors that may be related to the increased incidence of lower extremity injuries. We were able to establish that female collegiate cheerleaders have H:Q ratios well below the normative value of 0.6, which is the accepted cutoff indicative of having a muscular imbalance between the main muscle groups responsible for the primary movements of the lower leg [2,3]. This may be a contributing factor to the prevalence of lower limb injuries in female cheerleaders. However, these results must be interpreted with caution as our sample size is small and may not be indicative of all competitive cheerleaders.

**3. Conclusions**

Because of the female having a below normative value of 0.6 for H:Q ratios, female cheerleaders should increase their focus on conditioning and strength-training of the lower extremities to help avoid injuries. Coaches may potentially use these findings as performance evaluation tools to aid in identifying athletes at increased risk for lower-limb injury. However, additional research is needed to further establish this link with larger sample sizes.

**References**

[1] C.R. LaBella and J. Mjaanes.( 2012). Cheerleading injuries: Epidemiology and recommendations for prevention. *Pediatrics*, 130(5), 966-971.  
 [2] Jenkins, N. (2012) Functional hamstrings:quadriceps ratios in elite women’s soccer players. *Journal of Sports Sciences*, 1-6.  
 [3] Costa, P.B. (2011) Acute effects of static stretching on peak torque and H:Q, *Medicine & Science in Sports*, (23), 38-45.