Knee Extensor Strength Between Inter-University and Non-Inter-University Handball Players: A Cross-Sectional Isokinetic Assessment

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ABSTRACT:

Aim The present study assessed and compared knee extensor peak torque between inter-university (IUG) and non-inter-university (NIUG) male handball players using isokinetic dynamometry.

Methodology- Ten male handball players (age: 18–24 years; IUG n = 5, NIUG n = 5) enrolled at Lakshmibai National Institute of Physical Education (LNIPE), North East Regional Centre, Guwahati, India participated. Concentric knee extensor peak torque was assessed at 60°/sec using the HUMAC NORM isokinetic dynamometer. The Shapiro–Wilk test and Levene's test confirmed normality and variance homogeneity before inferential analysis.

Result - An independent-samples t-test revealed that the IUG demonstrated significantly greater knee extensor peak torque ($M = 99.60$ Nm, $SD = 6.23$) than the NIUG ($M = 77.80$ Nm, $SD = 5.89$), $t(8) = 5.69$, $p < .001$, 95% CI [12.96, 30.64] Nm, Cohen's $d = 3.59$ (very large effect). These findings indicate that inter-university competitive-level participation is associated with substantially superior knee extensor strength, likely attributable to greater exposure to structured, periodised resistance-training programmes. Strength and conditioning specialists working with non-inter-university players should prioritise progressive lower-limb resistance training to reduce this gap and minimise injury risk..

Keywords: isokinetic dynamometry, knee extensor strength, quadriceps, handball, inter-university athletes, peak torque, HUMAC NORM, competitive level.

Introduction

Muscular strength is recognised as a foundational physical quality underpinning performance across all team sports. Because every voluntary movement originates from muscle contraction, an athlete's capacity to generate and sustain force directly determines the ability to sprint, jump, change direction, and tolerate physical contact (Kraemer & Ratamess, 2004; Zatsiorsky & Kraemer, 2006). Systematic resistance training enhances force production, neuromuscular coordination, joint stability, and connective-tissue integrity, thereby improving both performance and injury resilience across a broad range of athletic contexts (Behm et al., 2017; Bompa & Buzzichelli, 2019; Faigenbaum & Myer, 2010).

Handball is a high-intensity Olympic team sport played by two teams of seven players on a 20 × 40 m court over two 30-minute halves. The sport's intermittent structure—characterised by repeated sprinting, jumping, throwing, physical contact, and rapid directional changes—imposes concurrent demands on anaerobic and aerobic energy systems (Michalsik & Aagaard, 2015). Because substitutions are unlimited, match intensity remains consistently high throughout competition, requiring players to maintain well-developed strength, power, speed, and endurance (Gorostiaga et al., 2006). Among the physical qualities underpinning handball performance, lower-limb muscular strength has received considerable research attention (Gorostiaga et al., 2006; Hermassi et al., 2011).

The knee extensor musculature (primarily the quadriceps femoris group) is centrally involved in handball-specific movements including sprint acceleration, vertical jump take-off, landing stabilisation, and rapid changes of direction. Adequate quadriceps strength not only determines explosive offensive output but also serves a protective function at the knee joint, with documented deficits associated with increased risk of anterior cruciate ligament (ACL) injury—among the most severe and prevalent injuries in court sports (Dvir, 2004; Hewett et al., 2005). Previous research has consistently reported superior lower-limb isokinetic strength in athletes at higher competitive levels, attributed to differences in training quality, volume, and intensity (Chelly et al., 2010; Gorostiaga et al., 2006; Hermassi et al., 2011).

Isokinetic dynamometry provides the gold-standard laboratory method for the objective, standardised measurement of muscular torque. By constraining movement to a constant preset angular velocity while accommodating variable resistance throughout the range of motion, these devices produce precise, reproducible torque values that are free from the confounds of external load variation (Brown, 2000; Dvir, 2004). The HUMAC NORM isokinetic dynamometer, used in the present investigation, is a well-validated instrument widely employed in sports medicine and performance diagnostics (Aagaard et al., 1998). Testing at 60°/sec is the established standard for maximal concentric strength assessment, as this slower velocity elicits peak torque values most representative of heavy-load force capacity (Aagaard et al., 1998; Dvir, 2004).

Despite the established importance of knee extensor strength in handball, comparative isokinetic data across competitive tiers—specifically inter-university versus non-inter-university players in the Indian context—remain scarce. Such data carry direct practical value by quantifying the strength gap between levels and informing targeted conditioning interventions. Therefore, the purpose of the present study was to assess and compare knee extensor peak torque at 60°/sec between inter-university and non-inter-university male handball players using isokinetic dynamometry. Based on available evidence, it was hypothesised that inter-university players would exhibit significantly greater knee extensor peak torque, reflecting the cumulative influence of more advanced and systematically supervised training environments.

Method

Research Design

A cross-sectional comparative design was employed to examine between-group differences in knee extensor peak torque at a single time point. No training intervention was administered; the study was observational and descriptive-comparative in nature, designed to determine whether competitive level was associated with measurable differences in isokinetic muscular strength.

Participants

Ten male handball players (age range: 18–24 years) were purposively selected from students enrolled at LNIPE, NERC, Guwahati, India. Inclusion criteria required active handball participation at either the inter-university or non-inter-university level, current enrolment in a B.P.Ed. or M.P.Ed. programme, and medical clearance from the institutional physician. Exclusion criteria included any musculoskeletal injury within the preceding six months and current use of medications known to influence muscular function. Following screening, participants were allocated to two equal groups: the inter-university group (IUG; n = 5), comprising players who had represented LNIPE, NERC in at least one Association of Indian Universities (AIU) handball tournament; and the non-inter-university group (NIUG; n = 5), comprising active players who had not achieved inter-university selection. This study was approved by the Institutional Ethics Committee of LNIPE, NERC, Guwahati, and all participants provided written informed consent prior to enrolment.

Variables

The independent variable was competitive level, operationally defined as two categories: inter-university (IUG) and non-inter-university (NIUG). The dependent variable was knee extensor peak torque (Nm), measured as the highest concentric torque value recorded at an angular velocity of 60°/sec.

Instrumentation

Knee extensor strength was assessed using the HUMAC NORM isokinetic dynamometer (Computer Sports Medicine Inc., Stoughton, MA, USA), a widely validated instrument in clinical and applied exercise science (Brown, 2000; Dvir, 2004). The device was calibrated to manufacturer specifications before each testing session. All assessments were conducted in the Sports Training Laboratory at LNIPE, NERC, Guwahati, under controlled environmental conditions (temperature: 22–24°C; relative humidity: 55–65%).

Testing Protocol

Participants reported to the laboratory in a rested state, having abstained from vigorous physical activity for 24 hours prior to testing. A standardised warm-up of five minutes of low-intensity stationary cycling preceded the assessment. Participants were positioned in the dynamometer chair with hip flexion at 85°, and the device rotation axis was aligned with the lateral femoral condyle of the dominant limb. Thigh, waist, and shoulder stabilisation straps were secured, and gravity correction was performed for each participant individually.

Four sub-maximal familiarisation repetitions at 60°/sec were completed to acquaint participants with the testing velocity. A standardised rest of 90 seconds was then provided, consistent with published isokinetic protocols (Aagaard et al., 1998; Dvir, 2004). Each participant subsequently performed five maximal voluntary concentric knee extension repetitions at 60°/sec. The highest peak torque value (Nm) across the five repetitions was recorded as the criterion measure. Standardised verbal encouragement was provided uniformly to all participants throughout testing to ensure motivational consistency.

Statistical Analysis

Data were analysed using IBM SPSS Statistics Version 20. Descriptive statistics (mean, standard deviation [SD], and standard error of the mean [SEM]) were computed for each group. Normality was verified using the Shapiro–Wilk test, and variance homogeneity was assessed with Levene's test, prior to inferential analysis. An independent-samples t-test was used to compare group means. Cohen's d was calculated as the index of practical effect magnitude, with values of 0.2, 0.5, and 0.8 representing small, medium, and large effects, respectively (Cohen, 1988). The 95% confidence interval (CI) for the mean difference was also reported. The alpha level was set at .05 for all statistical tests.

Results

Descriptive statistics are presented in Table 1. Assumption-testing results are reported in Table 2. Independent-samples t-test output is presented in Table 3. Effect-size estimates are summarised in Table 4. Figure 1 illustrates the group means with standard deviation error bars.

Table 1 Descriptive Statistics for Knee Extensor Peak Torque (Nm) by Group

Group	n	Mean (Nm)	SD (Nm)	SEM (Nm)
Inter-University (IUG)	5	99.60	6.23	2.79
Non-Inter-University (NIUG)	5	77.80	5.89	2.63

Note. SD = standard deviation; SEM = standard error of the mean; Nm = Newton-metres; IUG = inter-university group; NIUG = non-inter-university group.

The IUG recorded a mean peak torque of 99.60 Nm (SD = 6.23), while the NIUG recorded 77.80 Nm (SD = 5.89), representing a raw mean difference of 21.80 Nm (approximately 22%) in favour of the higher-competition group.

Table 2 Shapiro–Wilk Test for Normality and Levene's Test for Equality of Variances

Test	Statistic	df	p	Decision
Shapiro–Wilk — IUG	W = 0.921	5	.534	Normally distributed
Shapiro–Wilk — NIUG	W = 0.934	5	.617	Normally distributed
Levene's Test	F = 0.041	1, 8	.843	Variances homogeneous

Note. All $p > .05$, confirming that normality and variance homogeneity assumptions were satisfied prior to inferential testing.

Shapiro–Wilk tests confirmed normally distributed data in both the IUG ($W = 0.921$, $df = 5$, $p = .534$) and the NIUG ($W = 0.934$, $df = 5$, $p = .617$). Levene's test indicated no significant difference between group variances ($F = 0.041$, $p = .843$), confirming the homogeneity of variance assumption for the independent-samples t-test.

Table 3 Independent-Samples t-Test: Knee Extensor Peak Torque (Nm) Between Groups

Variance Assumption	t	df	p (2-tailed)	Mean Diff (Nm)	SED (Nm)	95% CI Lower	95% CI Upper
Equal variances assumed	5.686	8	< .001	21.80	3.83	12.96	30.64
Equal variances not assumed	5.686	7.98	< .001	21.80	3.83	12.95	30.65

Note. SED = standard error of the difference; CI = confidence interval. All significance values are two-tailed. Equal-variances-assumed row selected on the basis of Levene's $p = .843$.

The independent-samples t-test revealed a statistically significant group difference in knee extensor peak torque, $t(8) = 5.686$, $p < .001$. The 95% CI for the mean difference [12.96, 30.64] Nm did not include zero, confirming the statistical and practical reliability of the observed difference.

Table 4 Effect Size Summary for Group Differences in Knee Extensor Peak Torque

Parameter	Value	Interpretation
Mean difference (Nm)	21.80	IUG > NIUG
Pooled SD (Nm)	6.07	—
Cohen's d	3.59	Very large effect
95% CI for difference (Nm)	[12.96, 30.64]	Does not include zero

Note. Cohen's d = mean difference ÷ pooled SD. Pooled SD = $\sqrt{[(6.23^2 + 5.89^2) / 2]} = 6.07$ Nm. $d \geq 0.8$ = large effect (Cohen, 1988).

Cohen's d = 3.59 indicates a very large practical effect, confirming that the inter-university group's strength advantage represents a difference of substantial real-world magnitude, well beyond conventional benchmarks for a large effect.

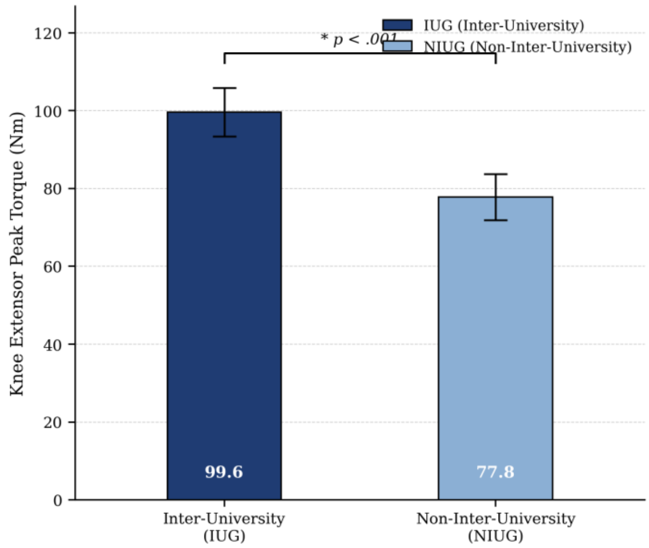

Figure 1. Mean (±SD) knee extensor peak torque (Nm) at 60°/sec for the inter-university group (IUG) and non-inter-university group (NIUG). Error bars represent ±1 SD. IUG: M = 99.60 Nm, SD = 6.23; NIUG: M = 77.80 Nm, SD = 5.89. *Significant group difference, $p < .001$; Cohen's d = 3.59.

Discussion

The principal finding of the present investigation was that inter-university handball players possessed significantly greater knee extensor peak torque than non-inter-university players (99.60 Nm vs. 77.80 Nm), yielding a very large effect size (Cohen's d = 3.59). This finding is consistent with the broader literature documenting that competitive level constitutes a meaningful predictor of lower-limb muscular strength in team-sport athletes (Gorostiaga et al., 2006; Michalsik & Aagaard, 2015).

The most plausible mechanistic explanation for the observed difference is differential exposure to structured, periodised resistance-conditioning programmes. Inter-university athletes at LNIPE typically train under institutional supervision with planned loading schemes that incorporate progressive overload, specificity, and adequate recovery (Bompa & Buzzichelli, 2019; Kraemer & Ratamess, 2004). Non-inter-university players are less likely to benefit from the same systematic conditioning environment. Hermassi et al. (2011) reported significant improvements in lower-limb strength and power following eight weeks of supervised resistance training in competitive handball players. A subsequent investigation confirmed that in-season explosive strength training produced meaningful gains in maximal leg strength in male handball players (Hermassi et al., 2019). A systematic review and meta-analysis by Bragazzi et al. (2020) further confirmed that resistance training consistently and substantially enhances maximal isokinetic strength and muscle power across competitive levels in handball, providing a mechanistic framework that supports the interpretation of the present group difference as reflecting accumulated training adaptation rather than inherent biological variation.

From a practical perspective, the 22% strength deficit observed in the NIUG represents a clinically and practically meaningful gap. The quadriceps femoris are primary contributors to sprint acceleration, vertical jump height, and dynamic knee stabilisation; deficits in quadriceps peak torque are associated with heightened vulnerability to ACL injury during the high-demand, explosive actions characteristic of handball competition (Dvir, 2004; Hewett et al., 2005). Beyond injury risk, this strength gap likely constrains performance across a range of handball-specific technical and tactical actions, including shooting power, defensive body positioning, and jump heading. Strength and conditioning specialists working with non-inter-university handball players should therefore prioritise progressive lower-limb resistance training—including compound exercises such as back squats, leg presses, and lunges—at intensities sufficient to elicit both hypertrophic and neural adaptations (Kraemer & Ratamess, 2004; Stone et al., 2007; Suchomel et al., 2016).

The present findings also underscore the importance of isokinetic testing as a monitoring and benchmarking tool in handball. Objective peak torque data at 60°/sec can guide individualized strength-development targets, track longitudinal adaptations, and inform return-to-play decision-making following knee injury. Normalising peak torque to body mass ($Nm \cdot kg^{-1}$) in future research would further improve comparability across studies and populations.

Limitations

Several limitations should be considered. First, the sample was restricted to n = 5 per group, constrained by the population available at a single institution. While the very large effect size (d = 3.59) provides confidence in the direction and magnitude of the finding, broader replication with larger, multi-institutional samples is necessary to establish generalisability and confirm adequate statistical power. Second, an a priori power analysis was not conducted, as normative isokinetic data for this specific population were unavailable; this is acknowledged as a methodological limitation. Third, potential confounding variables—including training history, weekly training volume and intensity, dietary intake, body composition, and sleep quality—were neither assessed nor controlled, and may have partially contributed to the observed differences. Fourth, testing was restricted to the dominant limb and to concentric contractions only; bilateral isokinetic assessment and eccentric strength measurement would provide a more comprehensive neuromuscular profile and enable computation of limb symmetry indices. Fifth, the cross-sectional design precludes causal inference; longitudinal designs or randomised controlled trials are required to establish whether structured resistance training is causally responsible for the observed strength advantage.

Conclusions

Inter-university handball players demonstrated significantly greater knee extensor peak torque than non-inter-university players at 60°/sec ($t(8) = 5.686$, $p < .001$, Cohen's $d = 3.59$, 95% CI [12.96, 30.64] Nm). The 22% strength advantage observed in the higher-competition group, and the very large effect size, highlight the likely influence of structured, supervised resistance-conditioning programmes on lower-limb muscular development. These results identify a clear performance and injury-risk gap between competitive levels and underscore the need for systematic strength development at the non-inter-university level. Future research should replicate these findings with larger multi-institutional samples, incorporate bilateral and eccentric isokinetic assessment, control for training and nutritional covariates, and prospectively examine the effects of targeted resistance-training interventions on knee extensor performance in this population.

Practical Applications

The present findings have direct implications for strength and conditioning practice in handball:

Non-inter-university handball players exhibit a substantial (~22%) deficit in knee extensor peak torque relative to their inter-university counterparts. Conditioning specialists should treat lower-limb strength development as a primary training objective for this population.

Progressive compound lower-limb resistance exercises (e.g., back squat, leg press, Romanian deadlift, split squat) prescribed at ≥75–80% 1RM across 3–5 sets are recommended to stimulate the neural and hypertrophic adaptations needed to close the observed strength gap.

Isokinetic dynamometry at 60°/sec is a reliable, standardised criterion measure for profiling and monitoring knee extensor strength across competitive levels. It should be incorporated into routine athlete screening, training monitoring, and return-to-play protocols in handball programmes.

The very large effect size (Cohen's $d = 3.59$) suggests that even a moderate, well-structured conditioning programme at the non-inter-university level could yield meaningful improvements in both performance and injury prevention, making such investment highly cost-effective for institutional sports programmes.

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