

Association Between Cervical ROM Changes and Head Impact Exposure in University Ice Hockey Players



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INTRODUCTION

Limited evidence exists on the effects of **repeated head impact (RHI)** exposure on **cervical (Cx) function** over the course of a competitive season.

The literature has largely focused on male athletes, with few studies directly comparing male and female participants to account for potential **sex-related differences**.

Cx range of motion (ROM) is a relevant indicator of cervical function, yet its **relationship with RHI exposure** remains poorly understood.

OBJECTIVES

- Explore cervical range of motion at two time-points (pre- and mid-season) in male and female university-level hockey athletes.
- Explore RHI biomechanics (quantity and intensity) in male and female university-level hockey athletes throughout a season.
- Correlate cervical range of motion changes with RHI biomechanics (quantity and intensity) in male and female university-level hockey athletes.

METHODS

Participants

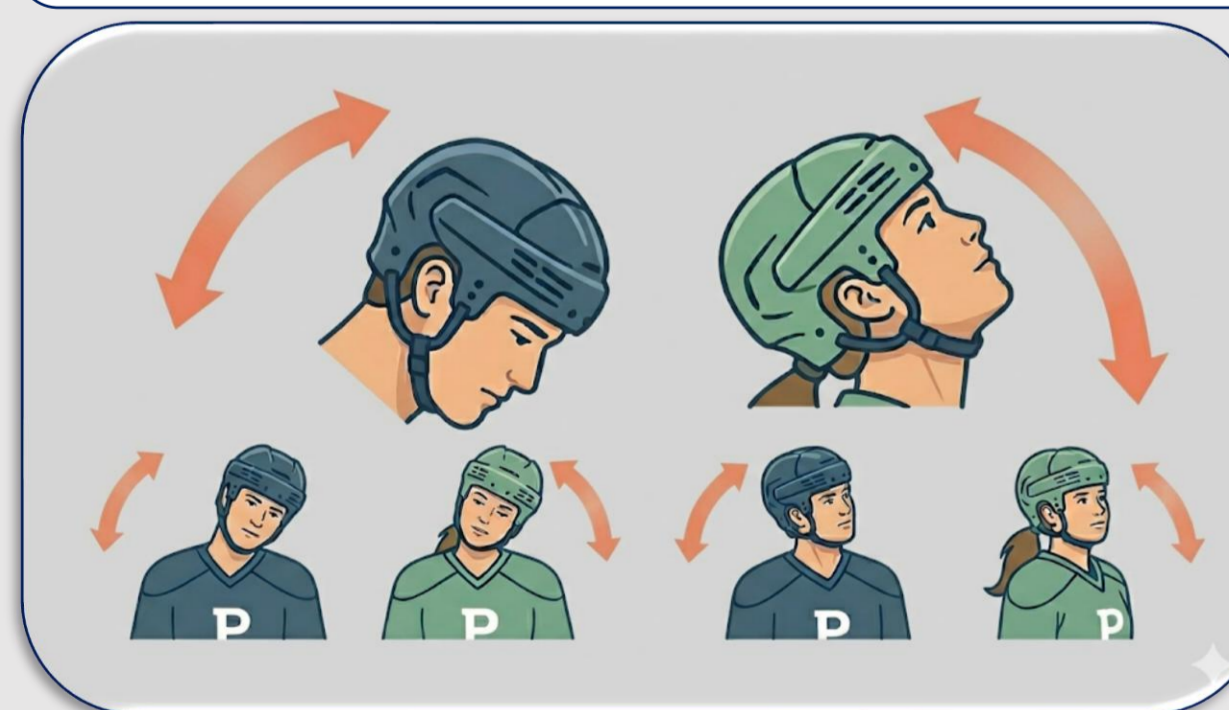


University-level hockey athletes from University of Montreal women's team and University of Quebec at Trois-Rivières men's team



Measures

Cx ROM in 6 directions



Average of 2 measurements per direction

Digital inclinometer



Timepoints

- Pre-season
- Mid-season
- During games



RHI monitoring system (Bearmind). Worn during games.

- Total number of impacts – quantity
- Cumulative impact intensity (g) – intensity

DEMOGRAPHICS

Table 1. Participants' characteristics

	Men's team-UQTR	Women's team-UdeM
Participant (n)	8	11
Age (y.o) [mean±SD]	23.4 ± 1.2	22.5 ± 1.9
Weight (lbs) [mean±SD]	194.4 ± 12.4	151.2 ± 18.8
Height (cm) [mean±SD]	183.5 ± 5.9	169.6 ± 7.2

RESULTS

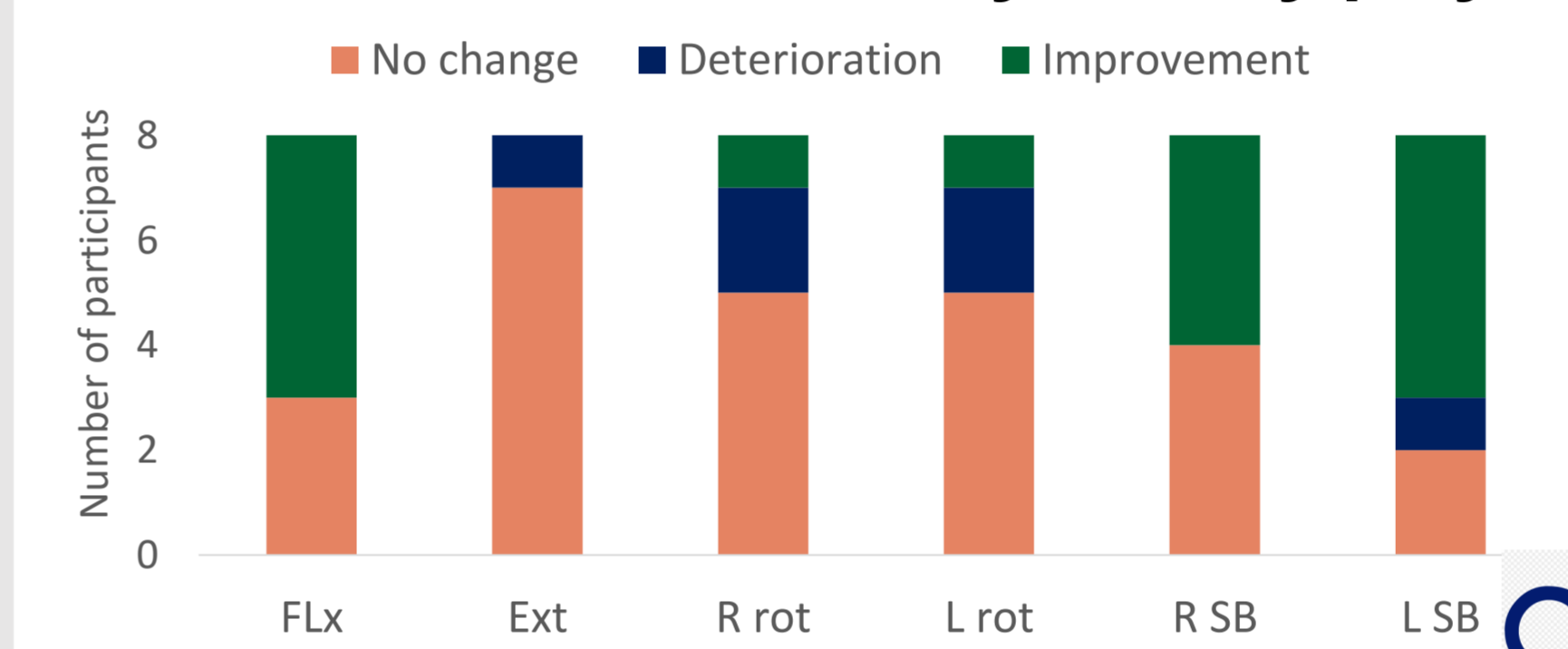


Table 2. Descriptive statistics of head impact exposure in first half of season in male and female hockey players

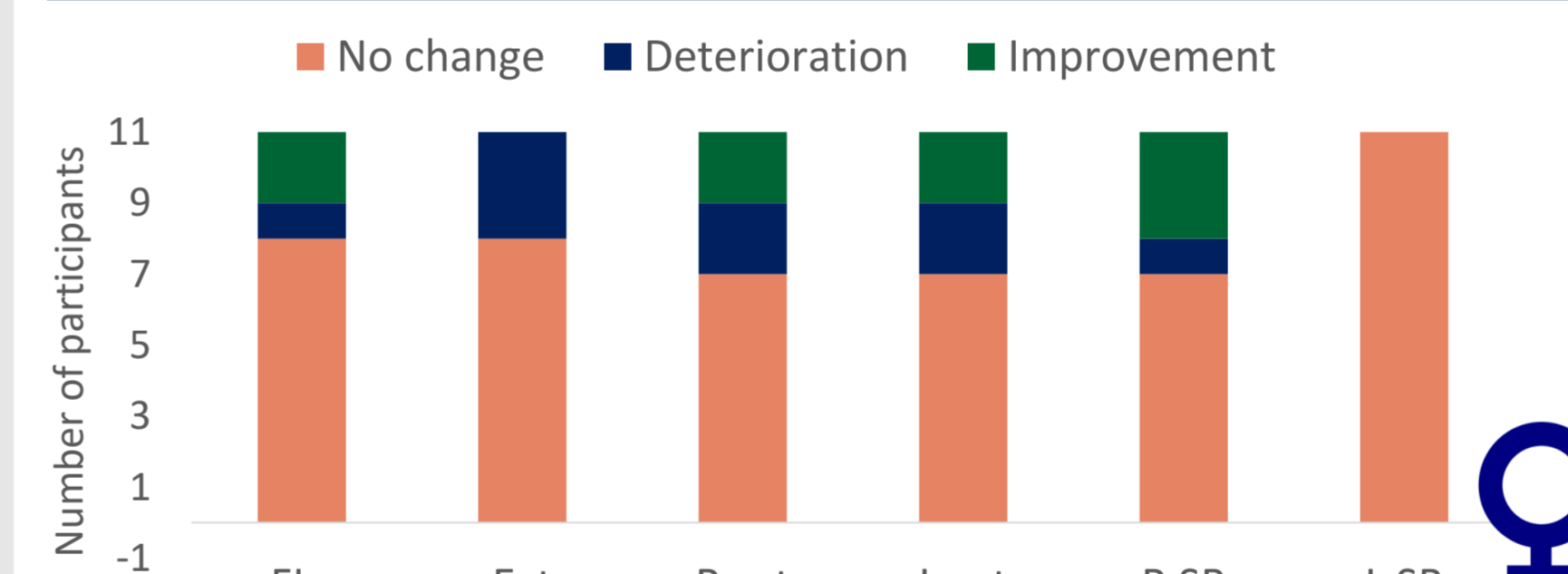


	Males			Females		
	Total Impacts (n)	Cumulative PLA (g)	Cumulative PRA (rad/s ²)	Total Impacts (n)	Cumulative PLA (g)	Cumulative PRA (rad/s ²)
Mean	31.8	884.35	1 665 878.1	7.45	158.55	275 749.745
Median	27	753.3	1 485 201.5	8	103	277 504.8
Range	13-72	369.8-2028.4	706 269.1-4 009 893	1-14	31-494.1	598 344.1

Figure 1. Distribution of cervical ROM changes during the mid-season period in male and female university hockey players

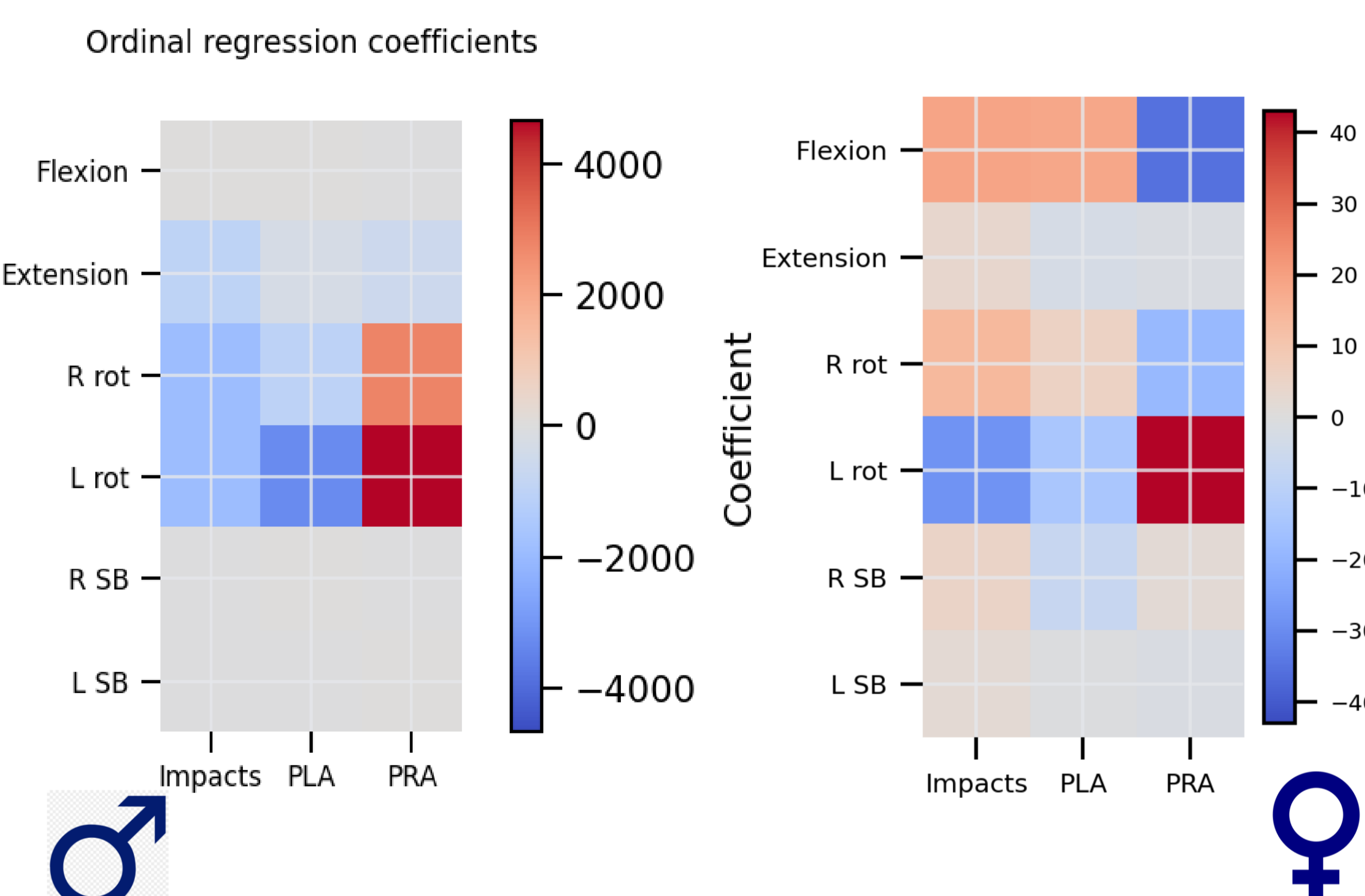


No statistically significant differences were observed in the direction of change across cervical movements ($p > .05$). Nevertheless, a consistent trend toward improvement was noted in flexion, right and left side bending.



No statistically significant directional changes were detected across cervical movements ($p > .05$). Descriptive patterns suggested a tendency toward improvement in flexion and right side bending and deterioration in extension.

Figure 2. Heatmap of associations between CX-ROM and RHI metrics in male and female university hockey players



After standardizing predictors, RHI metrics showed variable but generally weak-to-moderate associations with ROM outcomes, with patterns differing across movement planes.

After standardizing predictors, all variables show consistently weak associations with ROM outcomes.

CONCLUSION

- Both males and females showed trends toward improved flexion and side bending ROM but decreased extension ROM across mid-season.
- Male players sustained more impacts and greater linear and rotational forces than females.
- Weak-to-moderate associations were observed between impacts and extension/rotation ROM in males, with inconsistent directions. In females, associations were weak, and no clear pattern emerged. The study was underpowered, limiting definitive conclusions.

References

Brook, E. M., Kroshus, E., Hu, C. H., Gedman, M., Collins, J. E., & Matzkin, E. G. (2017). Incidence of Sports-Related Concussion Among NCAA Women's Ice Hockey Athletes. *Orthopaedic Journal of Sports Medicine*, 5(7), 232596711714445. <https://doi.org/10.1177/232596711714445>

Huber, C. M., Patton, D. A., McDonald, C. C., Jain, D., Simms, K., Lallo, V. A., Margulies, S. S., Master, C. L., & Arbogast, K. B. (2021). Sport- and Gender-Based Differences in Head Impact Exposure and Mechanism in High School Sports. *Orthopaedic Journal of Sports Medicine*, 9(3), 2325967120984423. <https://doi.org/10.1177/2325967120984423>

Kenny, R., Elez, M., Clansy, A., Virji-Babul, N., & Wu, L. C. (2022). Head Impact Exposure and Biomechanics in University Varsity Women's Soccer. *Annals of Biomedical Engineering*, 50(11), 1461-1472. <https://doi.org/10.1007/s10439-022-02914-3>

Mihalik, J. P., Guskiewicz, K. M., Marshall, S. W., Blackburn, J. T., Cantu, R. C., & Greenwald, R. M. (2012). Head Impact Biomechanics in Youth Hockey: Comparisons Across Playing Position, Event Types, and Impact Locations. *Annals of Biomedical Engineering*, 40(1), 141-149. <https://doi.org/10.1007/s10439-011-0405-3>

Schmidt, J. D., Guskiewicz, K. M., Blackburn, J. T., Mihalik, J. P., Siegmund, G. P., & Marshall, S. W. (2014). The Influence of Cervical Muscle Characteristics on Head Impact Biomechanics in Football. *The American Journal of Sports Medicine*, 42(9), 2056-2066. <https://doi.org/10.1177/0363546514536685>

Smith, L., Ruediger, T., Alsalaheen, B., & Bean, R. (2016). PERFORMANCE OF HIGH SCHOOL FOOTBALL PLAYERS ON CLINICAL MEASURES OF DEEP CERVICAL FLEXOR ENDURANCE AND CERVICAL ACTIVE RANGE OF MOTION: IS HISTORY OF CONCUSSION A FACTOR? *International Journal of Sports Physical Therapy*, 11(2), 156-163. <https://pmc.ncbi.nlm.nih.gov/articles/PMC4827359/>