Comparing GRF & Acceleration On Various Surfaces During Single-Leg Jumps

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Sports and Exercise Analytics

Intro/Background

- ACL/knee injuries occur more frequently in soccer/football (traditionally played on grass/artificial turf) more than any other sport[1]

- Approximately 70% of ACL ruptures occur during <u>single foot</u> contact in sport[2]

- Many grass fields are being converted into artificial turf in order to be more cost-effective in the long haul

- Leg injuries in sports like basketball (typically played on hard surfaces), generally occur when landing, rather than twisting

Table 1.

Anterior Cruciate Ligament (ACL) Injury Rates per 100000 Athlete-Exposures, High School Sports-Related Injury Surveillance Study, United States, 2007/2008–2011/2012[a]

	ACL Injuries			AEs			Rate per 100000 AEs			Rate Ratio (95% CI)[b]
	Competition	Practice	Total	Competition	Practice	Total	Competition	Practice	Total	
Sport										
Football	198	88	286	423874	2156763	2580637	46.7	4.1	11.1	11.5 (8.91, 14.72)
Boys' soccer	35	9	44	271345	643206	914551	12.9	1.4	4.8	9.2 (4.43, 19.18)
Girls' soccer	83	13	96	235 938	550355	786293	35.2	2.4	12.2	14.9 (8.30, 26.72)
Volleyball	15	5	20	284625	556983	841608	5.3	0.9	2.4	5.9 (2.13, 16.15)
Boys' basketball	18	7	25	328264	777796	1106060	5.5	0.9	2.3	6.1 (2.55, 14.59)
Girls' basketball	71	21	92	267297	627094	894391	26.6	3.3	10.3	7.9 (4.88, 12.91)
Wrestling	14	13	27	215378	594052	809430	6.5	2.2	3.3	3.0 (1.40, 6.32)
Baseball[c]	3	3	6	304200	557764	861964	1.0	0.5	0.7	1.8 (0.37, 9.08)
Softball	13	8	21	226111	431135	657246	5.7	1.9	3.2	3.1 (1.28, 7.48)
Sex Comparable[d]										
Boys	56	19	75	903809	1978766	2882575	6.2	1.0	2.6	6.5 (3.84, 10.86)
Girls	167	42	209	729346	1608584	2337930	22.9	2.6	8.9	8.8 (6.25, 12.30)
Total	450	167	617	2557032	6895148	9452180	17.6	2.4	6.5	7.3 (6.08, 8.68)
Boys	268	120	388	1543061	4729581	6272642	17.4	2.5	6.2	6.9 (5.52, 8.50)
Girls	182	47	229	1013971	2165567	3179538	17.9	2.2	7.2	8.3 (6.00, 11.40)

Abbreviations: AE, athlete-exposure; CI, confidence interval. Bold represents significant rate ratios.

[a] Table 1 represents unweighted data in order to calculate rates. All other tables and figures represent nationally representative weighted data.
[b] Calculated with practice as referent group.
[c] Caution should be used when interpreting results for sports with fewer than 10 total injuries such as baseball.
[d] Sex comparable sports included soccer, basketball, and baseball or softball.

Purpose

- Quantify peak GRF and total acceleration exerted on a subject during single-leg jumps on commonly used athletic surfaces

- Compare acceleration attenuation between accelerometers placed along subject's leg

Methods

- One, recreationally active male
  - 5ft, 8in
  - 150lbs
- Four different surfaces tested:
  - Baseline (force plate only)
  - Turf
  - Grass
  - Rubber
- MATLAB used to run data analysis

Data Collection

- Dominant single-leg drop landing from consistent height of 30.5 cm
  - *Five trials per surface*
- Kistler in-ground force plate
- Three Delsys triaxial accelerometers (2000 Hz)
  - *Placed on subject's landing leg*
  - *Foot, shank and quad*

- Parameters measured per surface
  - *Peak (vertical) Ground Reaction Force*
  - *Peak Total Acceleration*

Results - GRF

Average Peak GRF of Landing Surfaces
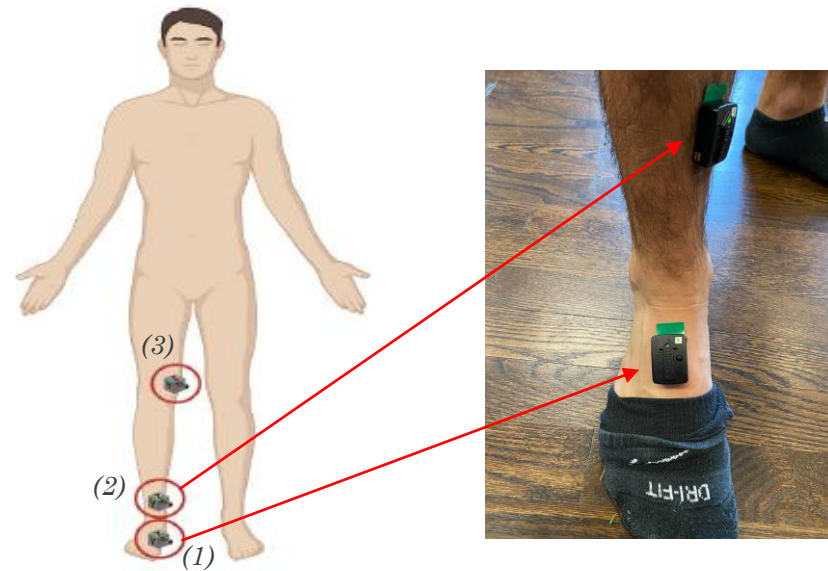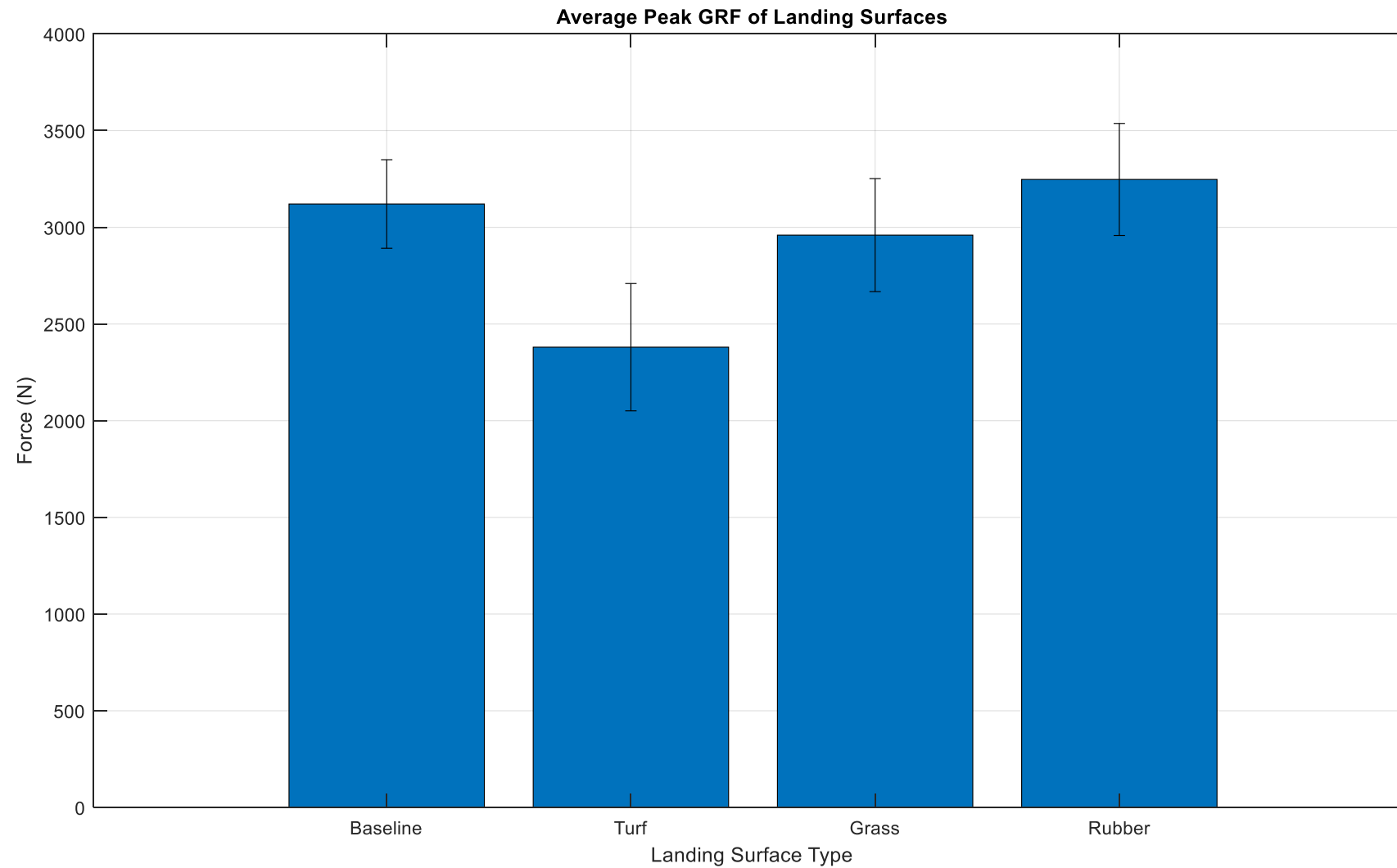
Results - Acceleration
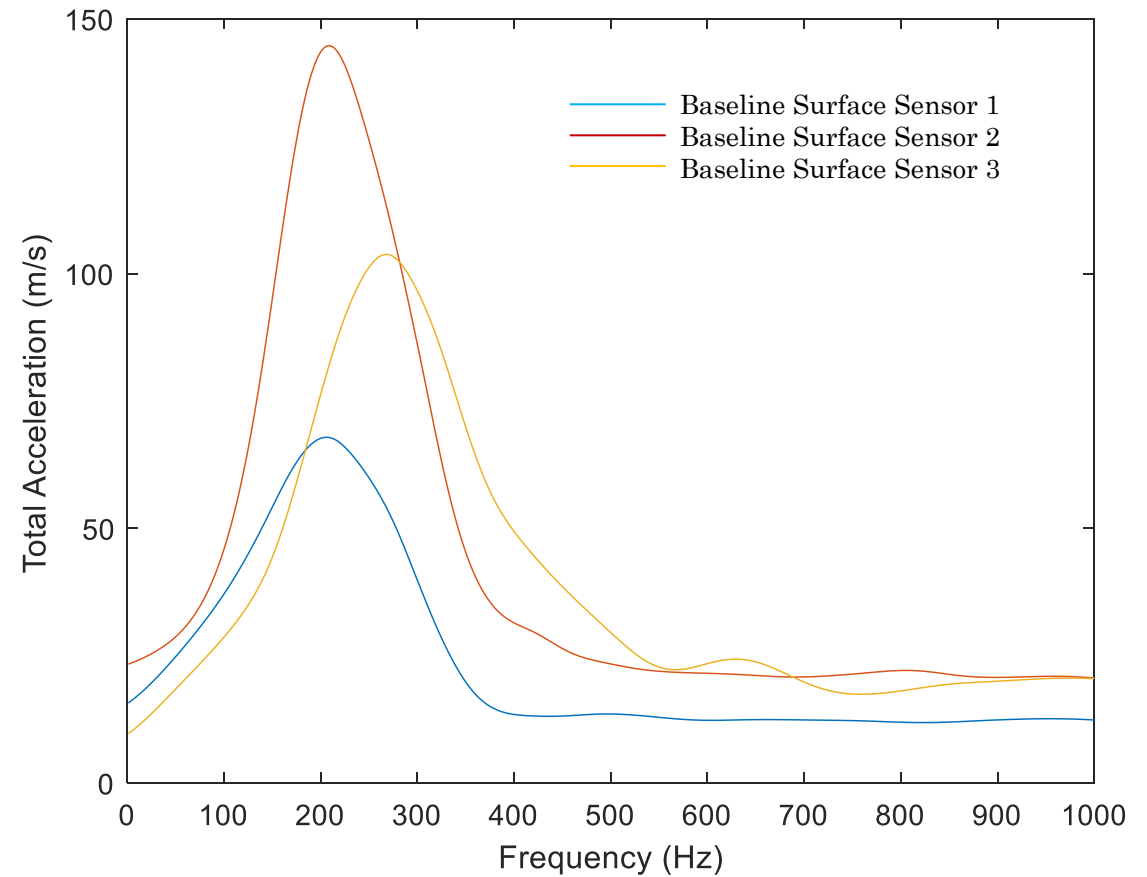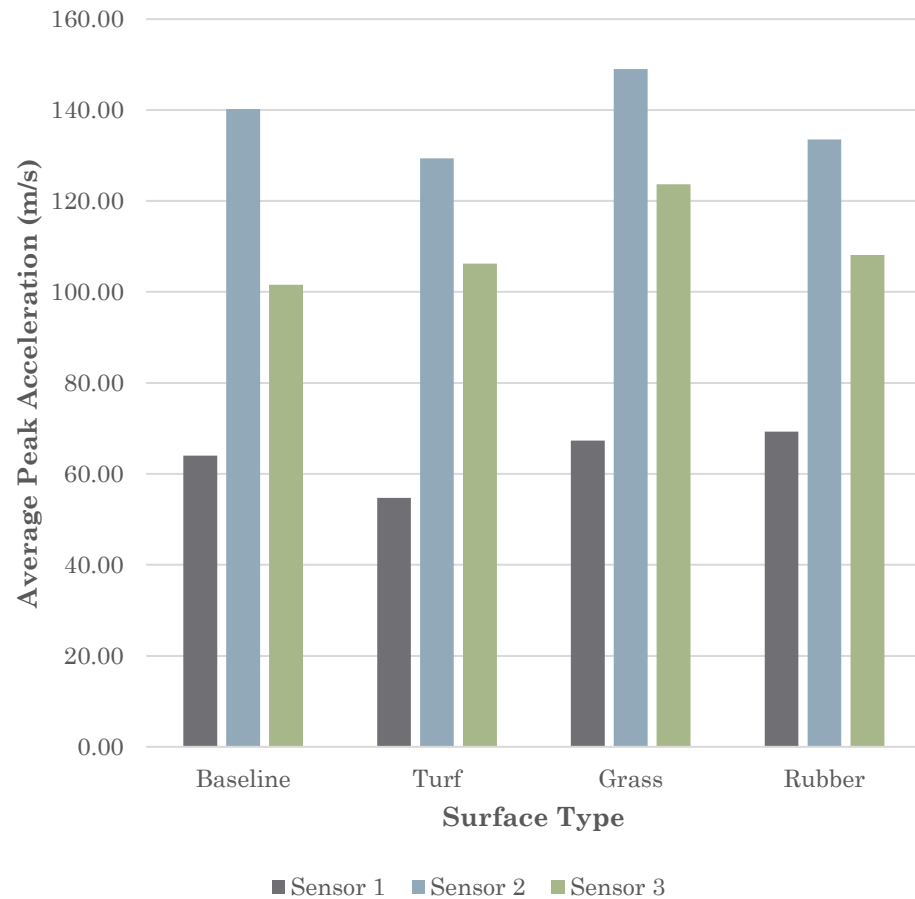
Results

Surface Type	Average Peak GRF	Average Peak Acceleration		
	GRF (N)	Sensor 1 (m/s)	Sensor 2 (m/s)	Sensor 3 (m/s)
Baseline	3120.6	64.0	140.2	101.6
Turf	2380.1	54.7	129.4	106.2
Grass	2959.6	67.3	**149.0**	**123.7**
Rubber	**3247.5**	**69.3**	133.5	108.1

Discussion

- Overall, the firmer surfaces accounted for the larger GRF compared to the softer ones

- Acceleration signal was greatest (for all surfaces) at sensor #2 (shank)

- The Grass surface accounted for the greatest acceleration at sensor positions further up the leg; consistent with more knee/leg injuries occurring on grass surfaces