JUMP LANDING DECELERATION: ESTABLISHING NORMATIVE RANGES FOR MALE AND FEMALE ATHLETES

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BACKGROUND

Lower extremity joint (LE) kinematics during landing tasks are important **predictors of injury** risk and **performance outcomes** in athletes.[1,2] The drop-jump landing task is a commonly employed method of injury screening in athletes and return to sport testing batteries.[3] Normative ranges for LE kinematics have not been established in athlete or general populations. The identification of normative ranges for LE kinematics during landing tasks in a large cohort of healthy individuals can inform the development of performance optimization, rehabilitation, and injury prevention programs.

PURPOSE

Establish sex-related normative ranges for LE kinematics during the drop-jump task in a large cohort of healthy military cadets.

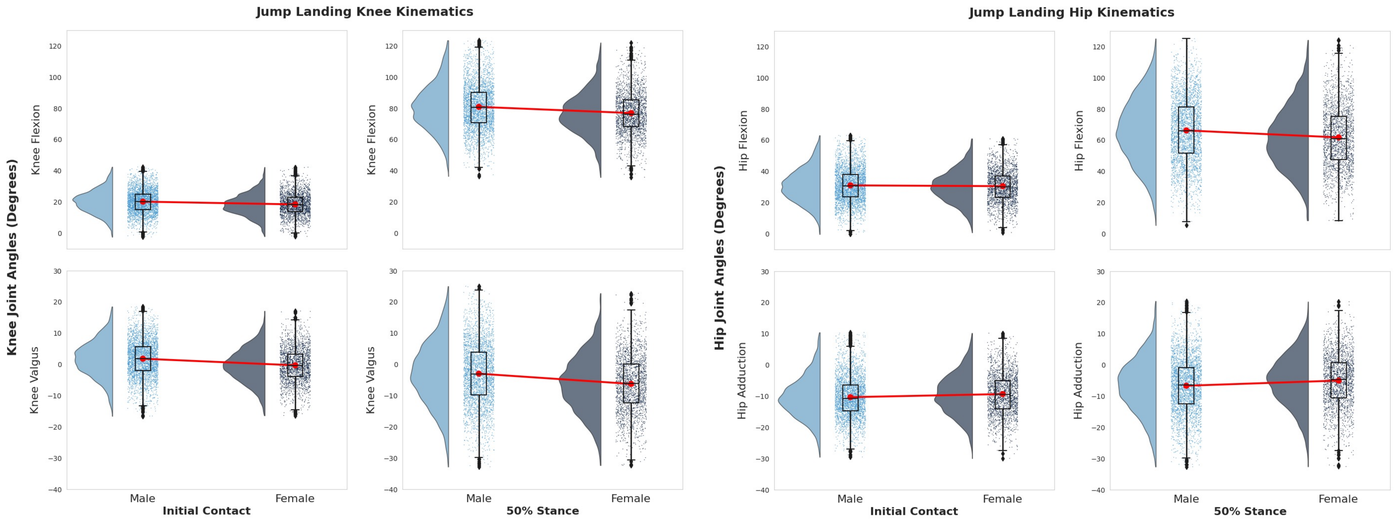

Figure 2. Raincloud Plots for Jump Landing Kinematics.[6] Hip Abduction (-) / Adduction (+). Knee Valgus (-) / Varus (+).

METHODS

5514 healthy military cadets (3371 males and 2143 females; age: 18.8 ± 0.9; BMI: 23.8 ± 2.9) participated in this study.[4] Dominant limb kinematics were collected using an electromagnetic motion analysis system during the drop-jump task (Figure 1), sampling at 144 Hz. Force plate data was collected with the kinematic data at a sampling rate of 1440 Hz. Initial ground contact was defined as the point when the vertical ground reaction force exceeded 10 N upon landing. 50% stance was defined as the point when the knee was at peak flexion. Sex-related differences in LE kinematics were analyzed using independent samples t-tests. Mean differences (MD) were reported for interpretability. Normative ranges were established for each joint angle in males and females separately at the initial contact and peak joint angles during stance.

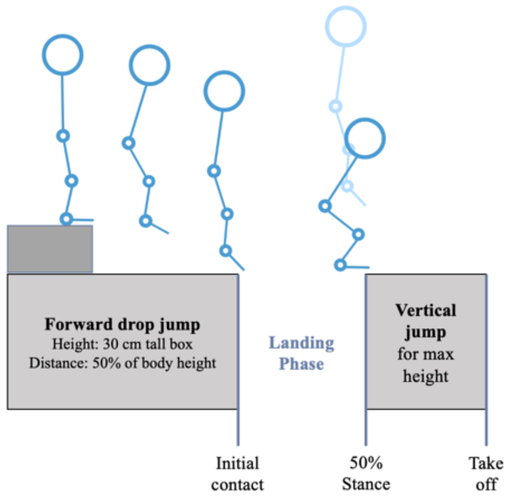

Figure 1. Drop Jump Landing task. Deceleration phase is defined as the first 50% of landing.[5]

RESULTS

Normative reference joint angles are presented as raincloud plots (Figure 2) for the 25th, 50th, and 75th percentiles for initial contact and at 50% of stance. Sex differences were observed in joint angles during drop jump landing kinematic analysis.

At initial contact, females on average exhibited **decreased knee flexion** (MD: -1.7˚, p < 0.001), as well as **greater knee valgus** (MD: 2.2˚, p < 0.001) and **hip adduction** (MD: 1.0˚, p < 0.001).

Similarly, at 50% stance, females exhibited **decreased knee flexion** (MD: -4.1˚, p < 0.001) and **hip flexion** (MD: -4.5˚, p < 0.001), accompanied by **greater knee valgus** (MD: 3.3˚, p < 0.001) and **hip adduction** (MD: 1.7˚, p < 0.001).

Table 1. Sample Statistics and Mean Differences by Sex.

	Males			Females				
	Mean	SD	95% CI	Mean	SD	95% CI	MD	p-value
BMI	24.39	3.13	(24.29, 24.5)	22.91	2.37	(22.81, 23.01)		
Age	18.87	0.97	(18.84, 18.9)	18.57	0.79	(18.54, 18.61)		
Weight	77.59	12.4	(77.17, 78.0)	62.9	7.95	(62.56, 63.24)		
Height	178.13	7.13	(177.89, 178.37)	165.61	6.5	(165.33, 165.88)		
Knee Flexion/Extension								
Initial Contact	20.26	7.55	(20.0, 20.51)	18.52	7.35	(18.21, 18.83)	-1.74*	<0.001*
50% Stance	80.95	15.03	(80.45, 81.46)	76.92	13.57	(76.35, 77.5)	-4.03*	<0.001*
Knee Valgus/Varus								
Initial Contact	1.8	5.85	(1.6, 2.0)	-0.43	5.53	(-0.67, -0.2)	-2.23*	<0.001*
50% Stance	-2.99	9.99	(-3.32, -2.65)	-6.28	9.1	(-6.66, -5.89)	-3.29*	<0.001*
Hip Flexion/Extension								
Initial Contact	31.02	10.92	(30.65, 31.39)	30.47	10.25	(30.03, 30.9)	-0.55	0.06
50% Stance	66.21	20.87	(65.51, 66.92)	61.7	19.86	(60.86, 62.54)	-4.51*	<0.001*
Hip Adduction/Abduction								
Initial Contact	-10.32	6.65	(-10.09, -10.54)	-9.31	6.69	(-9.03, -9.6)	-1.01*	<0.001*
50% Stance	-6.79	8.94	(-6.48, -7.09)	-5.05	8.45	(-4.69, -5.41)	-1.73*	<0.001*

Notes: Hip Abduction (-) / Adduction (+). Knee Valgus (-) / Varus (+). Greater negative value for valgus represents greater valgus, positive would indicate varus. Body Mass Index (kg/m^2), BMI; confidence interval, CI; mean difference, MD; standard deviation, SD. * Indicates statistical significance of p < .05.

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CONCLUSION

- This study provides normative ranges for LE kinematics during the drop-jump task in a large cohort of healthy military cadets.
- Sex-related differences in LE kinematics were observed. Females exhibited **stiffer sagittal** plane and **greater frontal** plane movement strategies during at initial contact and 50% stance of the drop-jump task.

APPLICATION

- The normative ranges for LE kinematics during the drop-jump task established in this study can be used by practitioners and researchers to identify those displaying aberrant movement patterns.
- These normative ranges may also aid in developing targeted programs to reduce injury and improve performance outcomes in male and female athletes.