Correlations and Gender-Related differences in Dynamic Postural Stability and Landing Kinematics in U.S. Marines

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BACKGROUND

- Unintentional musculoskeletal lower extremity (LE) injury is a health concern for the U.S. military
- The majority of non-battle injuries occur during physical training
- Several factors have been shown to be predictive of musculoskeletal injury including strength, flexibility, landing strategy, and postural stability
- Dynamic postural stability (DPS) is more often utilized in military and athletic populations
- DPS has been shown to differ between genders, but it is unknown if landing kinematics are related to DPS and if these strategies differ between genders
- Knowing what landing positions allow for more efficient postural control may be important for guiding physical training

PURPOSE

- To determine the relationship between landing kinematics and DPS in U.S. Marines
- To identify gender-related differences in landing kinematics and DPS in U.S. Marines

HYPOTHESES

- Male and female Marines that land with greater knee and hip flexion at initial contact (IC) and show greater peak knee flexion will have better DPS
- Female Marines will have better DPS and show different landing kinematics compared to males

SUBJECTS

- 199 male and 70 female U.S. Marines
  - Free of self-reported injury within the previous 3 months
- Demographics are presented in **Table 1**

Table 1. Group Demographics – Mean ± Standard Deviation

	Male	Female	p
n	199	70	
Age (years)	22.5 ± 2.7	22.7 ± 2.7	0.730
Height (m)	1.77 ± 0.07	1.64 ± 0.06	< 0.001*
Weight (kg)	80.2 ± 10.8	64.7 ± 10.8	< 0.001*

*Significant difference (p < 0.05)

METHODOLOGY

- 3-dimensional LE kinematics and ground reaction forces (GRF) were collected during a single-leg landing task (**Figure 1**)
- Participants were asked to take off from two feet, jump over a 30 cm hurdle and land on their test-leg in the center of the force plate
- The jump was initiated from 40 percent of the participant's height
- Upon landing, participants recovered their balance and held an upright position for 5 seconds

Data Reduction

- Knee and hip kinematics were calculated using the Plug-In-Gait biomechanical model
- Initial contact was identified when the vertical GRF exceeded 5 percent of the participant's body weight
- GRF during the first 3 seconds following initial contact were used to calculate a dynamic postural stability index (DPSI) representing dynamic postural control

MAIN OUTCOME MEASURES

- Test-limb knee and hip flexion angles were identified at IC and peak knee flexion angle was identified during the landing phase
- DPSI is a composite of the mean square deviations in the anterior-posterior, medial-lateral, and vertical GRF and is normalized to body weight

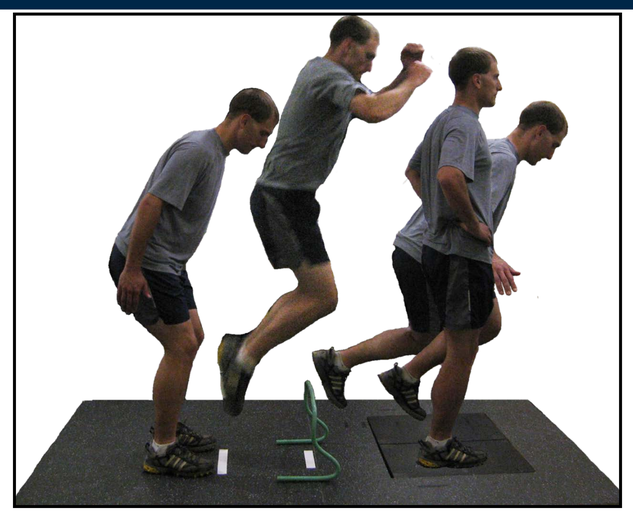

FIGURE 1: DPS

$$DPSI = \left(\sqrt{\frac{\sum(0 - GRFx)^2 + \sum(0 - GRFy)^2 + \sum(body\ weight - GRFz)^2}{number\ of\ data\ points}} \right) \div body\ weight$$

STATISTICAL ANALYSIS

- Data were not normally distributed, thus Spearman's correlation coefficients were used to identify significant correlations between DPSI and kinematic variables
- Mann-Whitney U tests were used to identify significant differences in outcome variables between male and female Marines
- Significance level was set at p<0.05 *a priori*

RESULTS

- DPSI was significantly correlated with hip and knee flexion angles at IC and peak knee flexion angle (**Table 2**)
- Female Marines had significantly lower DPSI and greater hip and knee flexion angles at IC compared to male Marines (**Table 3**)

Table 2. Pairwise Correlation Between DPSI and LE Kinematics

	DPSI	
Joint Angles (°)	**Coefficient‡**	**p**
Hip flexion at IC	-0.22	< 0.001*
Knee flexion at IC	-0.13	0.040*
Peak knee flexion	-0.18	0.003*

*Significant correlation (p < 0.05); ‡Spearman correlation coefficient

Table 3. Gender-Related Differences – Mean ± Standard Deviation

	Males	Females	p
DPSI	0.364 ± 0.034	0.348 ± 0.027	< 0.001*
Hip flexion at IC (°)	28.2 ± 6.4	32.5 ± 7.1	< 0.001*
Knee flexion at IC (°)	11.6 ± 4.7	13.9 ± 5.2	0.001*
Peak knee flexion (°)	52.6 ± 6.5	53.6 ± 6.9	0.182

*Significant difference (p < 0.05)

SUMMARY AND CONCLUSIONS

- Gender differences are present in DPSI and hip and knee flexion during a single-leg landing task
- Greater hip and knee flexion at IC and greater peak knee flexion during landing is correlated with better DPSI
  - Male and female Marines that display these landing patterns may be better able to absorb GRFs during landing and may be more stable during a single-leg landing task

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NMRL Website