THE EFFECTS OF SURFACE COMPOSITION DURING A 6-WEEK PLYOMETRIC TRAINING PROGRAM ON VERTICAL JUMP PERFORMANCE

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Abstract

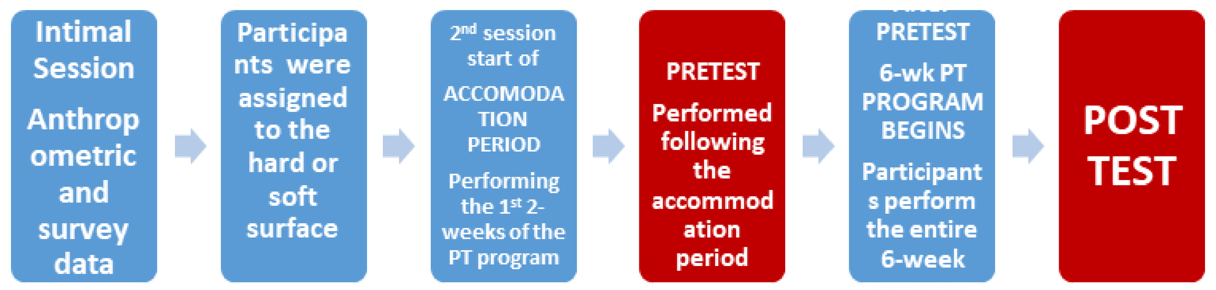
Plyometric training programs may be performed on a hard surface or a soft surface to target specific training adaptations and enhance jump performance. However, it is unknown how surface compliance impacts jump performance. **PURPOSE:** The purpose of this study was to compare the effects of a 6-week plyometric training program on a hard surface or soft surface on squat jump (SJ), countermovement jump (CMJ), and approach jump (AJ) performance. **METHODS:** Eighteen physically active university students (males = 9, females = 9; age: 20.3 ± 1.7 yrs; height 170.0 ± 70.0 cm; body mass: 67.1 ± 7.2 kg) volunteered to participate. Prior to training, the subjects completed a 2-week accommodation period to become familiarized with the training protocol. Following the accommodation period, pre-testing was performed which included the SJ, CMJ, and AJ. All jump trials were performed on a hard surface and measured using a Vertec until there was no increase in jump height. The trial with the greatest jump height from each jump was used for analyses. Subjects then completed a 6-week plyometric training program on either a hard surface or soft surface. Following training, post-testing was performed identical to the pre-testing. A 2 (Surface: Hard and Soft) x 2 (Time: Pre-test and Post-test) repeated measures ANOVA was used to examine the mean differences in jump height values for the SJ, CMJ, and AJ. **RESULTS:** The results of the present study indicated that there were no significant 2-way interactions (SJ: p = .708, η_p^2 = .02; CMJ: p = .483, η_p^2 = .06; AJ: p = .330, η_p^2 = .12) or main effects for Surface (SJ: p = .457, η_p^2 = .07; CMJ: p = .477, η_p^2 = .07; AJ: p = .373, η_p^2 = .10), but there were significant main effects for Time (SJ: $p < .001$, η_p^2 = .85; CMJ: $p < .001$, η_p^2 = .85; AJ: p = .001, η_p^2 = .74). For the SJ, CMJ, and AJ, the post-test values (SJ = 55.02 ± 8.77 cm; CMJ = 59.12 ± 9.41 cm; AJ = 62.05 ± 10.49 cm) were greater than the pre-test values (SJ = 50.59 ± 8.09 cm; CMJ = 56.03 ± 9.17 cm; AJ = 58.45 ± 9.75 cm). **CONCLUSIONS:** For the SJ, CMJ, and AJ, the current findings indicated that there were similar increases in jump height regardless of surface area. These findings suggested that there is a minimum intensity threshold, determined by the training surface area, necessary to induce training adaptations. Thus, professionals can tailor plyometric training programs to target either fast or slow stretch-shortening cycles by modifying the intensity via changes in surface area. **PRACTICAL APPLICATIONS:** Practitioners designing plyometric training programs to increase lower body vertical power may perform the training sessions on a soft surface or a hard surface and see similar improvements in vertical jump performance.

Background

Plyometric training (PT) is a popular training modality to increase vertical power. Initially, plyometric research predominantly involved elite or extensively trained athletes. While this research offered crucial insights into the advantages and potential drawbacks of PT, applying these findings directly to physically active individuals (PAI) is not necessarily straightforward. Initially, plyometric research predominantly involved elite or extensively trained athletes. While this research offered crucial insights into the advantages and potential drawbacks of PT, applying these findings directly to physically active individuals (PAI) is not necessarily straightforward. Although previous research has investigated the effects of PT on various surfaces, these studies have primarily focused on high school or elite athletic populations, leaving the impact of training surface on PAI unknown. Therefore, the purpose of this study was to compare the effects of a 6-week PT program on a hard or soft surface on changes in vertical lower body power assessed by; squat jump (SJ), countermovement jump (CMJ), and approach jump (AJ) performance in PAI.

Methods

Participants: Were randomly assigned to soft and hard training groups while counterbalancing group placement by sex. The soft surface training group included 5 males and 4 females (mean age: 20.3 ± 1.7 year; body mass 67.1 ± 7.2 kg; height 1.7 ± 0.1 m), while the hard surface training group included 5 males and 4 females (mean age: 22.1 ± 5.6 year; body mass 72.3 ± 16.8 kg; height 1.7 ± 0.1 m). **Testing Procedures: (a) Standardized Warm-up:** 10 repetitions of: jump rope, air squats, ankle hops, and countermovement jumps at a self-selected intensity with a 1-minute rest between each exercise for all training and testing sessions. **(b) Familiarization:** 3 submaximal SJ, CMJ, and AJ with an arm swing. **(c) Testing:** Maximal SJ, CMJ, and AJ separated by 30 seconds per jump, until no improvement in performance was achieved. Best trial recorded to the nearest half inch. **Accommodation Period**: Performed the 1st 2-weeks of the PT program. **Training Protocol:** Each training group performed an identical mixture of plyometric exercises. All participants performed two supervised training sessions per week separated by at least 48 hours for a total of 12 training sessions (See Table 1). Participants were allowed to miss two training sessions throughout the program. Training warm-up: standing long jumps and ankle hops that covered 25 meters in distance, followed by 10 CMJs. The warm-up was performed on the same surface as assigned for training. 30-second breaks were taken between each set and a 1-minute break occurred between each exercise. ***Statistical Analysis:*** The mean differences for SJ, CMJ, and AJ were compared using three 2 (Surface: soft and hard) x 2 (Time: pre-test and post-test) repeated measures ANOVAs. An alpha level of $p \leq .05$ was used to determine statistical significance. Effect sizes were reported as partial eta squared (η_p^2) and Cohen's d (calculated as $(Mean_2 - Mean_1) / SD_{pooled}$) for the ANOVAs and mean differences.



Results

Squat Jump: The results of the repeated measures ANOVA for SJ indicated no significant 2-way interaction ($F_{1,16}$ = 0.51, p = .484, η_p^2 = .03) and no significant main effect for surface ($F_{1,16}$ = 0.17, p = .686, η_p^2 = .01). There was a significant main effect for time ($F_{1,16}$ = 38.19, $p < .001$, η_p^2 = .71, d = 0.53; see Table 2). ***Counter-Movement Jump:*** The results of the repeated measures ANOVA for CMJ indicated no significant 2-way interaction ($F_{1,16}$ = 0.41, p = .530, η_p^2 = .03) and no significant main effect for surface ($F_{1,16}$ = 0.48, p = .499, η_p^2 = .03). There was a significant main effect for time ($F_{1,16}$ = 56.14, $p < .001$, η_p^2 = .78, d = 0.33; see Table 2). ***Approach Jump:*** For the AJ, the results of the repeated measures ANOVA indicated no significant 2-way interaction ($F_{1,16}$ = 0.76, p = .398, η_p^2 = .05) and no significant main effect for surface ($F_{1,16}$ = 0.73, p = .406, η_p^2 = .044). There was a significant main effect for time ($F_{1,16}$ = 29.36, p = .001, η_p^2 = .65, d = 0.36; see Table 2).

Table 1

6-week Plyometric Training Program Protocol

Week	Volume (Foot Contacts)	Plyometric Exercises	Sets x Reps
1	90	Lateral ankle hops*	2 x 15
		Counter-movement jump*	2 x 15
		Front barrier jumps*	5 x 6
2	120	Lateral ankle hops*	2 x 15
		Standing long jump*	5 x 6
		Lateral barrier jumps**	2 x 15
		Tuck jumps**	5 x 6
3	120	Lateral ankle hops*	2 x 12
		SLJ*	4 x 6
		Lateral barrier jumps**	2 x 12
		Tuck jumps**	3 x 8
		Lateral barrier jumps**	2 x 12
4	140	Diagonal barrier jumps*	4 x 8
		Standing long jump with lateral sprint**	4 x 8
		Lateral barrier jumps**	2 x 12
		Single leg bound***	4 x 7
		Side to side unilateral jumps***	4 x 6
5	140	Diagonal barrier jumps*	2 x 7
		Standing long jump with lateral sprint**	4 x 7
		Lateral barrier jumps**	4 x 7
		Barrier jumps with half turn**	4 x 7
		Single leg bound***	4 x 7
		Side to side unilateral jumps***	2 x 7
6	120	Diagonal barrier jumps*	2 x 12
		Hexagon drill*	2 x 12
		Barrier jumps with directional sprints**	4 x 6
		Tuck jumps**	3 x 8
		Side to side unilateral jumps***	4 x 6

Note. * = low intensity; ** = medium intensity; *** = high intensity.

Table 2. *Descriptive statistics for surface condition jump height (cm).*

	Soft Surface		Hard Surface		All Surfaces	
Variable	Mean	SD	Mean	SD	Mean	SD
Squat jump*						
Pre	48.6	10.7	52.6	9.8	50.6	10.3
Post	53.3	12.7	56.7	11.1	55.0*	11.9
Post-Pre	4.7		4.1			
All Times	51.0	11.7	54.7	10.4		
Counter-movement jump*						
Pre	53.9	14.0	58.2	10.0	56.0	12.0
Post	57.3	14.5	61.0	10.1	59.1*	12.3
Post-Pre	3.4		2.8			
All Times	55.6	14.2	59.6	10.0		
Approach jump*						
Pre	56.1	14.0	60.8	11.4	58.5	12.7
Post	59.1	15.1	65.0	11.8	62.1*	13.5
Post-Pre	3.0		4.2			
All Times	57.6	14.5	62.9	11.5		

Note. *Post-test jump height significantly greater ($p < .05$) than pre-test jump height.

Conclusion

- Vertical power development/ jumping performance is not primarily influenced by the training surface.
- The PT program plays a major role
- Practitioners should prioritize individual goals and consider both training surface preference and availability when designing PT programs

Practical Application

Broadening Applicability

- The use of a non-athletic population broadens the scope of PT beyond sports performance for athletes.

Evidence-based Guidelines

- Demonstrating similar enhancements in jump performance on different surfaces
- Helping practitioners tailor programs to individuals needs and preferences

Surface-specific Adaptations

- Understanding the basis of jump improvement on different surfaces

Importance of Variation

- Variation in training surfaces to prevent monotony
- Practitioners consider incorporating different surfaces to maximize training effectiveness