Optimal Angle of Knee Flexion for Maximal Vertical Jump in Division III Collegiate Athletes

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Introduction

Vertical jumping is an action utilized by athletes of all ages in many different sports; and maximizing performance is frequently a goal of strength and condition programs. By finding an optimal knee flexion angle preceding a vertical jump, one could maximize performance. Researchers and trainers have attempted to find the most efficient jump technique to maximize vertical power output[1]. Peak muscular force is attainable when there is optimal length-tension relationship in the agonist muscles and optimal activation of the stretch-shortening cycle[2]. Minimizing the amortization phase[3] and optimizing the angle of knee flexion preceding the vertical jump[4] will help to achieve these biomechanical and physiological goals.

Purpose

The purpose of this study was to assess the effect of three countermovement knee flexion take-off angles (50,80, and 110 degrees) on vertical jump height.

Materials and method

12 male Division III football skill position players volunteered to participate in the study.

Standing knee flexion angles of 50, 80, and 110 degrees were measured with a goniometer. At each angle, the corresponding eye level height was marked on a mirror placed in front of the subject (see Figure 2).

Consistent with the methods used in previous research, construction paper was placed on a mirror at the proper height in order for the subject to know when to cease their downward countermovement[4] (see Figure 3).

Subjects performed three maximal effort countermovement jumps, with eccentric loading to designated knee flexion, and vertical jump height measured by a Just Jump mat. One minute of rest was given between jumps.

Testing was performed in the field house at Saint John's University.

Results

A repeated measures ANOVA revealed a significant effect of knee flexion angle [$F(2,22) = 25.268$, $p \leq 0.001$] (see Table 1). Post hoc test revealed a small to large effect size differences (see Table 2).

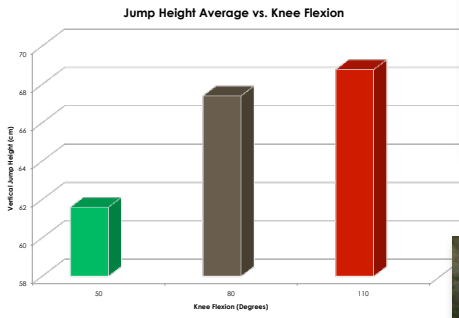

Figure 1. Comparisons of varying take off knee flexion angles and their average jump heights.

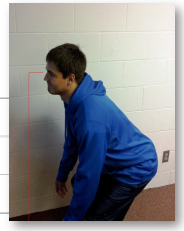

Figure 2.Methods

Figure 3. Methods

	Degrees of Knee Flexion			Significance
	50	80	110	
Jump Height Average (Cm)	61.60 ± 4.75	67.41 ± 5.99	68.78 ± 6.07	$p \leq .001$

Table 1. Results of average jump height (centimeters) (N=12) measured throughout varying take off knee flexion angles (degrees) and the significance between the variables.

Knee Flexion Degree Variance	Significance	Effect Size
50 vs. 80	$p \leq .001$	d =1.07 (Large)
50 vs.110	$p \leq .001$	d =1.32 (Large)
80 vs. 110	p = .412	d = .227 (Small)

Table 2. Comparisons of varying take off knee flexion angles with probability of significance and effect size.

Discussion

Consistent with previous research[5], the optimal knee flexion angle for maximal vertical jump height was greater than 50 degrees.

Distinguishing whether there is an optimal knee flexion angle between 50 degrees and 80 degrees still needs to be determined with further research.

Vertical jump height appears to continue to increase with deeper knee flexion, however it needs to be further researched to find out if and when knee flexion can become too deep.

The results found in this study can provide useful knowledge regarding vertical jump training by suggesting a proper range of optimal knee flexion take-off angles.

Future research could examine a jump that would be performed at the subject's "preferred position" of knee flexion. This "preferred" angle would provide insight into whether the body intuitively optimizes the angle of knee flexion in eccentric loading to maximize vertical jump height.

Conclusion

There was an increase in vertical jump height with increasing knee flexion take-off angles past 50 and up to at least 110 degrees.

Our hypothesis was inconclusive in showing that 80 degrees is the sole optimal knee flexion take-off angle.

An implication of this study is that knee flexion take-off angles of greater than 50 degrees should be encouraged when testing maximum countermovement jump height performance. This will promote valid and reliable vertical jump height measurements.

Literature cited

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Acknowledgments

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