

INTEGRATING SPORT BIOMECHANICS AND EXERCISE PHYSIOLOGY FOR TRAINING COLLEGIATE ATHLETES DURING A COMPETITION SEASON

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INTRODUCTION: Sport specificity training involves the design and implementation of strength training and conditioning programs tailored to a specific sport with the goal of optimizing performance. When training collegiate athletes during a competition season there is an even greater emphasis placed on optimization. This is because the NCAA places time restrictions on collegiate athletes that effectively limit the volume of training that any one athlete can participate in per week. As a result, coaching staffs need to maximize time devoted to skills based training while still ensuring sufficient time is allocated for developing an athlete to peak physical conditioning and rest (Marques, et al., 2006).

The goal of this paper is to present a framework for integrating sport biomechanics and exercise physiology within the design of sport specific training programs. Research from both fields has direct applicability to sport specificity training and integration is often an implicit dimension to such research. Yet, comparably few studies have been explicit about how to best integrate biomechanics and exercise physiology within the context of sport specificity training. Although this paper specifically uses Women's Collegiate Volleyball as a case study, the intent is to initiate discussion regarding the need to explicitly integrate sport biomechanics and exercise physiology when developing strength training and conditioning programs for collegiate athletes.

METHODS: First, a typical, mid-week, in season, Women's Division II Collegiate Volleyball practice was filmed. This practice was broken down by drill to determine three different components. The first component was to determine the biomechanics of sport specific movements performed by a starting outside hitter, middle hitter, setter, and libero. Player movements were counted whenever a sudden change of player position on the court was identified during the work portion of a drill. These movements were broken down according to cardinal directions with north being oriented towards the net. Additionally, three sport specific movements were included. These included the attack jump, the block jump, and defensive crouch. The second component was to determine the relationship of on-court movements to strength and conditioning exercises. These were determined by the authors who have multiple years of experience designing strength and conditioning programs for collegiate volleyball. Moreover these lifts are commonly integrated into current strength and conditioning programming for volleyball (Hedrick, 2007). Lastly, the volume and intensity of on-court movements and foot contacts were quantified by counting the number of movements identified above and calculating the work-to-rest ratio. The work-to-rest ratio was calculated by using an internal clock embedded into the video media software (Windows Media Player, 2007). Work time was calculated starting at the beginning of play/drill and stopped at the end of play determined by a dead ball or an abrupt end of player activity (Iosia & Bishop, 2008). Using data from the film analysis a periodized, sport specific training program was written.

RESULTS AND DISCUSSION: Table 1 summarizes the analysis of the film data for a starting outside hitter and indicates that several sport specific movements common to volleyball are identifiable. Each of these movements seek to maximize lower body and upper body power, which are intended to rapidly change an athlete's horizontal and vertical position in the playing area. For instance, when conducting the attack jump the athlete engages in two phases of movement to generate maximum vertical jump height along with

forward momentum toward the net before transitioning into a third phase of movement intended to generate upper body power to attack the volleyball (Cisar & Corbelli, 1989).

Translating the biomechanics of sport specific movements to strength training and conditioning exercises should consider the different phases of a single action, in this case the attack jump. Plyometrics such as box jumps are a good example of a common strength and conditioning exercise that corresponds only to the first two phases of the attack jump. However, from a biomechanics perspective the attack jump is a multi-planar, multi-jointed action, as are most movements specific to the sport of volleyball. In order to replicate the transition into the third phase of the attack jump variations of Olympic-style lifts such as a fast tempo front squat transitioning into a jerk or push-press may be more appropriate. Variants of lifts such as these more closely reflect the multi-joint, multi-planar movement specific to the sport, rather than focus solely on one muscle group in a single plane like the squat alone does (McGill, et al., 2009). More so, such lifts develop both speed and strength, which are the two components of power.

Prescribing volumes based on number of repetitions for a periodized strength training and conditioning program that is sport specific also benefit from data collected through an analysis of practice film. For instance, within the microcycle it will be necessary to shift to a lower volume during the course of the week. The goal of this reduction is to provide a taper for the athlete to maximize performance in weekend matches. Thus, early in the week it may be beneficial to overload the athlete with exercises that correspond to on-court movements identified in the film study. However, in order to taper for competition a reduction of volume should occur. This is because, as the film data shows, a substantial volume is already being reached during team practices. The danger of prescribing additional workouts during the taper phase of the microcycle is that it may result in overtraining and decreased performance. Similarly, quantifying the volume of in practice movements using film, measured as total number of foot contacts, can provide an additional source of information for determining overall training loads prescribed throughout the competition season macrocycle. The goal at this scale is, again, to avoid overtraining athletes while ensuring that they continue to make gains in physical conditioning in order to peak at the onset of post-season play.

Table 1. Summary of film data for a starting outside hitter during a typical mid-week competition season practice.

Movement	Muscles Recruited	Example of corresponding exercise	Volume
Attack Jump	Primary: Trunk, lower extremity, shoulder and upper extremity	Tempo front squat (or power clean) to jerk	53
Block Jump	Primary: Lower extremity, trunk. Secondary: upper extremity	Tempo front squat (or power clean) to push press	23
Defensive Crouch	Primary: Lower extremity, trunk	Half squat	22
Lateral movement	Primary: Lower extremity, trunk	Ground based Plyometrics	394

CONCLUSION: Sport biomechanics and exercise physiology play a significant role in designing sport specific training programs for collegiate athletes. Explicitly integrating research from these two fields is one way to optimize an athlete's physical conditioning in light of limitations placed on training schedules during the competition season. The framework advocated here suggests that sport specific movements occurring during organized team practices should be factored into the design of periodized, sport specific, strength training and conditioning programs. This framework integrates sport biomechanics

with exercise physiology and employs the use of film analysis as one method to analyze sport specific movements and quantify the volume of those movements during practices.

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