INTRODUCTION

Volleyball is a very popular sport with an estimated 800 million participants worldwide. The game involves many physical skills and successful performance is highly related with an individual's ability to propel themselves into the air during both offensive and defensive maneuvers. These ballistic activities often result in the creation of ground reaction forces on the order of five times body weight (Adrian & Laughlin, 1983). The deleterious effects of these forces may be compounded when one considers that a front row player may jump numerous times during a regulation match.

The jump landing sequence is the most common source of injury in volleyball (Briner & Kacmar, 1997). The majority (90%) of injuries occur in the lower extremity with the knee joint being particularly vulnerable. Injuries to the knee joint are especially important because they are associated with more lost time from sports participation than other injuries sites (Solgård, et al., 1995). Perhaps the most serious knee injury in volleyball involves rupture of the anterior cruciate ligament (ACL). The issue is further complicated because females are more likely to suffer an ACL injury than their male counterparts.

It has been hypothesized that the high number of jumps and the likelihood of losing balance due to deviations in jumping technique are the primary causes of injury during volleyball. However, little research exists regarding the prevalence of jumping and landing techniques in elite female volleyball. The purpose of this study was to quantify the number of jumps performed by elite female volleyball players in a competitive match and to determine the relative frequency of different jumping techniques.

PROCEDURES

A videotape recording of a match between two Division IA female volleyball teams was analyzed for this study. Both teams were considered elite (ranked in the top 10 nationally) at the time the match was played (fall of 2000). During the four game match, 593 jumps and landings were executed. Thirteen different front row players performed the jumping activities.

The videotape was played back at reduced speed in order to accurately observe several aspects of the jumping activity. Each activity was categorized by jump type (offensive spike or defensive block) and phase (jump or landing). Phase was further categorized by foot use patterns (right foot, left foot, or both feet). Each factor was scored in a categorical manner.

Four chi-square analyses were performed to determine whether jumping techniques occurred in disproportionate amounts relative to jump type, phase, and foot use patterns ($\alpha=0.05$).
RESULTS AND DISCUSSION

All tests were statistically significant (P<0.001). The majority (86.5%) of offensive jumps were performed using both feet. Most (50%) offensive landings occurred with both feet, but 38.9% resulted in a left foot first landing, while 11.1% utilized a right foot first technique. Over 98% of defensive jumps used both feet. Defensive landings involving both feet were most prevalent (47.2%) followed by right foot landings (36.0%) and left foot landings (16.8%). The distribution of jumps and landings appears in Table 1.

The overwhelming majority of propulsive jumps (offensive and defensive) are performed using both feet. Jumping with both feet provides a wide base of support resulting in stable force production and allowing the forces to be generated by both limbs for maximal vertical performance. Although more landings are made with two feet than with one, the relative frequencies for landing are far more variable than for the jump phase. Approximately half of all landings in volleyball utilize only the right or left foot. Accordingly, the most frequent mechanism of knee injury in volleyball is landing from a jump (Ferretti, et al., 1992). The relatively high number of asymmetric footfalls during landing may lead to loss of balance and subsequent injury. Interestingly, 62.5% of right foot jumps result in right foot landings and 59.4% of left jumps end in left foot landings. Additionally, most jumps are made with two legs, but half of the associated landings are made with only one leg. Thus a single leg must dissipate the forces originally created by both legs. This situation could be quite detrimental.

SUMMARY

Volleyball is a high-risk sport relative to the knee joint and landing techniques appear to be quite variable. Further kinematic and kinetic analyses of these different landing techniques are required to fully quantify the biomechanical risks of performing these tasks.

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REFERENCES


### Table 1: Distribution of jumps and landings.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Right foot</th>
<th>Left foot</th>
<th>Both feet</th>
<th>χ²</th>
</tr>
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<tbody>
<tr>
<td>Offensive jump</td>
<td>8</td>
<td>32</td>
<td>256</td>
<td>377.97</td>
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<tr>
<td>Offensive landing</td>
<td>33</td>
<td>115</td>
<td>148</td>
<td>70.84</td>
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<tr>
<td>Defensive jump</td>
<td>2</td>
<td>2</td>
<td>293</td>
<td>570.2</td>
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<tr>
<td>Defensive landing</td>
<td>107</td>
<td>50</td>
<td>140</td>
<td>41.88</td>
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