DIFFERENCES OF 2-D KNEE JOINT KINEMATICS DURING JUMP LANDINGS IN DIFFERENT FEMALE ATHLETIC POPULATIONS

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INTRODUCTION
Female athletes have a higher risk for sustaining ACL injuries as compared to their male counterparts by a factor of 2.4 to 9 [1-4]. 70% of the injuries occur during landing form a jump in non-contact situations [5]. Potential reasons for the higher incidence are anatomic, hormonal and biomechanical gender differences. It has been demonstrated that female athletes use different kinematic strategies and neuromuscular movement coordination [6]. Females have been shown to land more upright with less knee flexion thus producing a higher tension in the ACL. This repeated overloading mechanism might increase the injury potential in female athletes. While the gender differences appear well established and generally accepted it is unclear whether athletes participating in different types of athletic activities are at a different risk due to a more pronounced lack of conditioning for knee stability. Therefore, the aim of the present study was to compare competitive female athletes from different sports activities – football (soccer) (F), volleyball (V), gymnastics (G), and swimming (S) – with respect to their landing strategies after drop jumping. The groups were chosen to represent activities with high and low jumping demand with or without ball involvement.

METHODS
Fifty-eight healthy experienced athletes volunteered to participate in the study. Previous knee surgery served as an exclusion criterion. Subjects were recruited from local clubs and University teams and were required to have been actively participating in their sport for at least five years, i.e. exercising regularly several times per week. Informed written consent was obtained from all participants. The average age of the groups was similar with the exception of the slightly younger swimmers: F (n=15): 22.4±1.7 years, V (n=15) 22.1±3.7 years, G (n=16) 22.8±3.4 years, S (n=12) 19.2±3.5 years. The anthropometric data revealed slight differences in the BMI with the football players displaying the highest value: F 23.0±2.8 kg/m², V 21.6±1.7 kg/m², G 22.0±1.7 kg/m², S 20.5±2.0 kg/m².

Two-dimensional kinematics were recorded with a commercial digital video camera (Sony DCR-TRV 900E) that was positioned 6.5 m in front of the subject. A shutter speed of 1/3500 s was used to prevent blurring due to the moving objects on the images. The subjects were equipped with six reflective markers placed on the hip, knee and ankle joint (bilaterally) in order to determine the knee flexion angle (sagittal plane) and the knee varus/valgus (frontal plane). Subjects were asked to jump down from a 32 cm aerobic step and land on both feet. Five trials were recorded from a frontal view and five from a sagittal view with the dominant leg facing the camera. The videos were online digitized with a frequency of 50 Hz in a laptop computer and were analyzed with a commercial software that allowed a semi-automatic tracking of markers and subsequent analyses (KineView version 3.0 and KineWorks 3.1.75; Kine, Iceland). Non-parametric statistics were used to determine general group effects on selected parameters and pair-wise comparisons between two groups with an alpha-level of p<0.05.

RESULTS
Knee joint stability – as assessed with the Rolimeter (Aircast Inc.) – did not reveal significant differences between the four groups. However, the swimmers exhibited a larger degree of active knee extensibility during bilateral stance than the gymnasts or football players (F 9°, V 11°, G 9°, S 13°); the differences were significant between S vs. F (p=0.019) and S vs. G (p=0.026). The maximum knee flexion angle during the landing movement was significantly reduced in the football players (70°) as compared to the gymnasts (78°, p=0.005) and volleyball players (78°, p=0.029) (Fig. 1). Furthermore, the soccer players displayed the largest standard deviation indicating the most pronounced inter-individual variability. Frontal view kinematic analyses did not reveal extreme knee valgus positions during landing and did not result in any significant differences between the groups.

DISCUSSION
As was demonstrated before, women tend to land in a more extended hip and knee joint position [7]. In our subjects, the least knee flexion during landing was seen in the football players so that they might be the ones which are more on the ‘risky end’. Lately however, the importance of the frontal plane knee moments has been stressed [8]. An increased valgus knee moment has been described as being discriminative for female athletes at higher risk. In the present four subject groups, the frontal plane knee motion was rather inconspicuous and none of the subjects presented extreme valgus knee positions in the maximal flexion phase. This might indicate that the present sample might have been a slightly positive selection with well-conditioned athletes. Especially the swimmers who are never required to perform landings in their sport demonstrated a surprisingly well-controlled performance. It has to be considered, however, that they perform regular strength training that might have helped to develop their knee stabilizing muscles. In conclusion, the present results have demonstrated that athletes with different sports experience may also differ with respect to their knee kinematics after landing from a jump. This might have implications for specific intervention programs that try to achieve a reduction of knee injuries in female athletes.

REFERENCES

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