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Biomechanical Analysis of the Knee during an Immersive, High-Intensity Exergame Training in Healthy Athletes

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Background:

Exergaming – physically active gaming – is cognitively and physically challenging, and, therefore, has great potential for sports rehabilitation, for example after knee injuries. Before it can be recommended for rehabilitation, the biomechanics during exergaming needs to be understood. The occurrence of high-risk movement patterns for knee injuries, an abducted, internally rotated knee at 10-30° of flexion, needs to be monitored [1,2]. This study aimed to compare the amount of knee valgus (KV) and knee internal rotation (KIR) at 10-30° of knee flexion during different exercises of an immersive, functional, high-intensity, interval exergame (Figure 1) in healthy athletes.

Figure 1: High-touch during an ExerCube Training

Materials and Methods:

- Measurement of kinematics during a 25-minute exergame training (ExerCube) [3]
- Motion capture (Vicon) of the hip and knee with clusters (Figure 2)
- 18 athletes (9 female, 9 male) without prior knee injuries
- Outcome: Mean maximal KV and KIR during 10-30° knee flexion
- Comparison of 9 exercises [4]
- Two-way within-subject linear mixed model with post-hoc t-test

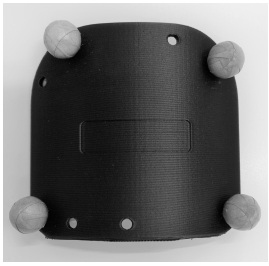

Figure 2: Marker Cluster

Results:

Exercise (side)	Knee Valgus [°]	Knee Internal Rotation [°]
	Mean (SD)	Mean (SD)
Punch (ipsilateral)	**8.5 (0.04)**	**13.2 (0.9)**
High-touch (contralateral)	**8.5 (0.1)**	9.11 (0.2)
High-touch (ipsilateral)	8.4 (0.1)	**11.7 (0.6)**
Mid-touch (ipsilateral)	8.4 (0.1)	**10.9 (1.3)**

Table 1: Mean angles of selected exercises compared to the other exercises. SD = standard deviation. **Significant differences**

Conclusion:

High-touches, mid-touches, and punches result in knee kinematics related to an increased risk of injury in healthy athletes. The inclusion of these movements during exergame-based rehabilitation should be carefully managed and performed in later stages of rehabilitation. Based on these findings a therapeutical exercise concept after knee injury was derived and transferred to the design of a new user-centered exergame scenario for sports rehabilitation (Figure 3).

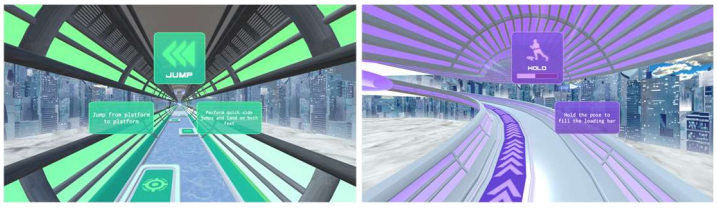

Figure 3: New User-Centered Exergame Scenario

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