COMPARING PEAK GROUND REACTION FORCES & ACCELERATION ON DIFFERENT SURFACE TYPES DURING SINGLE-LEG JUMPS

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INTRODUCTION

In sports, athletes play on a variety of surfaces such as a court, grass, artificial turf, ice or even concrete in some recreational sports. Depending on the surface the athlete is exposed to, the surface may have more or less 'give' to it than others, which can influence injury risk. For example, more ACL injuries occur in soccer and football (traditionally played on grass surfaces) than basketball[1] (typically played on wood court or concrete). This begs the question, what role does the surface an athlete plays on have on the both the ground reaction force (GRF) and acceleration exerted on the athlete? Understanding how different surfaces work during an impact can aid in developing safer surfaces and advanced training techniques to limit the number of injuries in athletics. The purpose of this study will be to compare both GRF and acceleration exerted on a male athlete when landing on common surfaces used in athletics.

METHODS

One male athlete performed five single-leg jumps onto four different surfaces from a fixed height of 305mm. Subject attempted to replicate the exact jumping motion to the best of their ability. Samples of turf (18mm thick), grass (40mm thick), rubber (12mm thick) and a 'baseline surface' using an in-ground force plate were used as the testing surfaces. The Kistler force plate was placed underneath the non-baseline surfaces to measure kinetic data at 1000 Hz and the force plate was initially zeroed-out to remove natural force of the external surfaces before impact. Three Delsys accelerometers (2000 Hz) were also placed on three locations (foot, shank and quad) on the subject's landing leg to measure acceleration during impact. GRF and acceleration data were imported into MATLAB, using only values from impact onto surface and thereafter. A Butterworth filter with a cutoff frequency of 10 Hz was then applied to smooth each set of data (for both GRF and Acceleration trials).

RESULTS AND DISCUSSION

The largest peak ground reaction force was found on the firmer surfaces (rubber and the baseline force plate). The rubber surface recorded on average 36% and 10% more force than the turf and grass surfaces, respectively. This suggests that the softer surfaces (grass and turf) may be better at absorbing vertical force than firmer ones. Leg injuries in sports such as basketball, usually played on a firmer surface, generally occur during landing, compared to sports like soccer where more turning/twisting of the leg is required and is played on grass. Hence, the average acceleration values measured on the shank (sensor 2) and quad (sensor 3) suggest the grass surface accounted for the greatest acceleration upon impact. This is consistent with previous studies that suggest more knee injuries (specifically ACL), occur on grass surfaces. Across all the surface types, the two sensors positioned higher up on the subject's leg experienced greater acceleration than the sensor directly on the foot, likely relating to the acceleration caused from when the heel comes down on the landing motion.

Table 1: Average peak GRF and acceleration across different landing surfaces

Surface Type	Average Peak GRF	Average Peak Acceleration		
	GRF (N)	Sensor 1 *(m/s)*	Sensor 2 *(m/s)*	Sensor 3 *(m/s)*
Baseline	3120.6	64.0	140.2	101.6
Turf	2380.1	54.7	129.4	106.2
Grass	2959.6	67.3	**149.0**	**123.7**
Rubber	**3247.5**	**69.3**	133.5	108.1

CONCLUSION

While many factors influence injury-risk during athletics, surfaces can play a role in limiting the amount of force and acceleration exerted on an athlete. Future studies may look to examine a subject's landing-then -jumping data to see how the force and acceleration immediately shift during that movement phase.

REFERENCES

[1] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3867093