A Quantitative Analysis of Ground Contact Time, Impulse, and Average Force in Various Plyometric Exercises

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Abstract

Purpose: Hurdle hops and jumping variations have long been used as cephalic, reactive movements by strength coaches in order to promote athletic strength and agility. The intent of this particular study was to separate the shorter distance agility drills and their effects on ground contact time, impulse, and average force. The methodology involved comparing the different movements to determine which were the most advantageous to use in their training regiment.

Methods: The Department of Human Kinetics and Applied Health Science was separated into 4 groups of 10 athletes divided into two different phases. Phase one was split into athletes that performed countermovement jumps (CMJ) and depth drop jumps (DDJ) and were randomly assigned to groups. Phase two included athletes that performed Antagonistic Facilitated Specialized Movement (AFSM), hurdle hops (HH), and Depth Drop Jumps (DDJ) and were randomly assigned to groups. The athletes were instructed to perform the jumps as rapidly and explosively as possible. Data was collected with a Kistler force plate and analyzed using SPSS.

Results: The data revealed that the AHL athletes displayed significantly shorter ground contact times in the hurdle hops as compared to both jump variations (p=.000, HH=633N*s±65N*s, DDJ=768N*s±85N*s). Additionally, three paired-sample t-tests provided significant differences between hurdle hops and the two jump variations (p=.000, HH=2905±354N, AFSM=2115N±213N, DDJ=2720N±285N). From these results, the athletes displayed a significantly higher impulse in the hurdle hops as compared to both jump variations (p=.000, HH=13333±1333N*s, AFSM=8500N*s±900N*s, DDJ=10000N*s±1000N*s). Furthermore, rate of force development is an essential component in the change of momentum, or impulse, that an athlete is capable of generating. As reflected in the results, the total impulse of both jump variations (AFSM and DDJ) was significantly lower in the hurdle hops (HH=633N*s±65N*s, AFSM=450N*s±45N*s, DDJ=768N*s±85N*s), and average force produced (p=.000, HH=2905±354N, AFSM=450N±45N, DDJ=2720N±285N).

Conclusion

As reflected in the results, the total impulse of both hurdle jumps (AFSM and DDJ) was significantly higher than the total impulse of the hurdle hops. A higher impulse indicates a larger change in momentum. It appears that during the AFSM and DDJ the athletes were more focused on creating a maximal effort in order to produce the greatest possible impulse in their individual jumps while in the hurdle, as opposed to the hurdle hops where the athletes were less concerned with this change in momentum. A change in momentum in jumping variations could originate from an instantaneous leveling of downward momentum or an additional movement of ground contact time, or a combination of both. In both cases, the athletes that were instructed to perform hurdle hops were able to produce greater forces to their jumps and produce the greatest change in momentum. This allows us to say that the AFSM and DDJ resulted in significantly higher force production per trial than the hurdle hops.

As noted in the introduction, the athletes that performed hurdle hops were instructed to perform jumps as rapidly and explosively as possible. These shorter ground contact times were likely contributed to the shorter amount of time that the athletes spent in contact with the force plate. The data also revealed significantly shorter ground contact times in the hurdle hops as compared to either jump variation. These shorter ground contact times most likely contributed to the smaller amount of time that the athletes spent in contact with the force plate. The data also revealed significantly shorter ground contact times in the hurdle hops as compared to either jump variation. These shorter ground contact times most likely contributed to the smaller amount of time that the athletes spent in contact with the force plate. The data also revealed significantly shorter ground contact times in the hurdle hops as compared to either jump variation. These shorter ground contact times most likely contributed to the smaller amount of time that the athletes spent in contact with the force plate. The data also revealed significantly shorter ground contact times in the hurdle hops as compared to either jump variation. These shorter ground contact times most likely contributed to the smaller amount of time that the athletes spent in contact with the force plate. The data also revealed significantly shorter ground contact times in the hurdle hops as compared to either jump variation. These shorter ground contact times most likely contributed to the smaller amount of time that the athletes spent in contact with the force plate. The data also revealed significantly shorter ground contact times in the hurdle hops as compared to either jump variation. These shorter ground contact times most likely contributed to the smaller amount of time that the athletes spent in contact with the force plate.