

MECHANICAL DETERMINANTS OF SPRINT PERFORMANCE IN ELITE AND SUB-ELITE FIELD HOCKEY PLAYERS.

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The aim of the present study was to investigate the difference in the horizontal mechanical determinants of sprint performance in highly-trained elite field hockey players versus sub-elite field hockey players. Thirty-five highly trained field hockey players (18 elite international players and 17 sub-elite players) were tested during the competitive season. They performed a maximal 40 meter sprint. Distance was tracked over time via a 312 Hz laser (Laser Technology, Inc) and used to calculate, for each individual, a horizontal force–velocity profile. Elite players showed a larger theoretical maximal horizontal velocity (v_0) compared to the sub-elite hockey players. No significant differences in theoretical maximal horizontal force (F_0) and horizontal power (P_{max}) between the groups were observed. Large variability especially in the sub-elite groups was observed in F_0 and v_0 , indicating the potential for individualized training program focusing on the weaker parameter.

KEY WORDS: sprint, acceleration, performance, hockey

INTRODUCTION: Running and accelerations are an integral part of the game in field hockey. The use of Global Positioning Systems has given us more insight in the intensity of running activities during competition. It has recently been shown that similar to other team sports, field hockey players' movements are characterized by short bursts of very high-intensity running activities combined with low-intensity activities for recovery and periods of inactivity (White & MacFarlane, 2013). The average distance covered during a field hockey competition is between 6 and 8 km (Jennings et al., 2012; White & MacFarlane, 2013). Higher running distances (up to 10.7 km) have been found during international competitions (Jennings et al., 2012). Although field hockey players spend most of a game exercising at low intensity (e.g., standing, walking, and slow running), the production of repeated actions at high or sprint intensity is crucial for success in this sport. Elite field hockey has been suggested to be played at higher intensity than other team sports with relative distances (i.e., the distance covered as a function of the time elapsed) in excess of 130 m/min reported (compare 110 m/min in soccer, etc) (Cummins et al, 2013). However, due to the low sampling frequency of the GPS system more insight in the sprinting performance or the ability to accelerate in elite field hockey players has not been investigated.

In soccer, it has been shown that professional players have become faster over time (Haugen et al, 2013) and that acceleration and maximum sprinting speed have been reported to distinguish players from different standards of play (Haugen et al., 2013). During the acceleration phase of sprinting, forward orientation of ground reaction force (GRF) has been shown to be a stronger determinant of field sprint performance than the overall magnitude of vertical or resultant GRF (Morin et al, 2012). These studies were until recently restricted to running on a treadmill in a laboratory setting. However, a promising new approach was recently developed, based on the instantaneous speed changes during a maximal sprint in the field (Samozino, Morin, et al., 2013). This modelling technique allows determining each individual mechanical properties of sprint running propulsion: theoretical maximal horizontal force (F_0), maximal horizontal power (P_{max}), theoretical maximal speed (V_0), and in turn, a force/velocity profile (Morin et al., 2012; Samozino et al., 2012). The impact of these variables on acceleration and maximum sprinting speed, is however, still unknown. The aim of the present study was therefore to examine, in highly trained hockey players, the horizontal mechanical determinants of acceleration and maximum sprinting speed.

METHODS: 35 highly trained field hockey players (18 elite players who participated in international competition and 17 sub-elite players who participated in the Belgian national first league) were tested during the competitive season, after at least two days of easy technical/tactical training (i.e., neither high-intensity running nor resistance training). All

player performed a rigorous warming up, including athletic drills (e.g., skipping, high knee runs), five short bursts of progressive accelerations on the track and two maximal 15-m sprints. All sprints were performed in an indoor facility on a synthetic track. Players wore their own running sport shoes.

Speed measures: Players started each 40 meter sprint at their own convenience from a standing start and completed two trials with the best performances retained for analysis. The best performance was defined as the test with the highest maximal speed. Instantaneous speed was measured continuously throughout the entire sprint via a 312 Hz laser (Laser Technology, Inc.- Universal Laser Sensor) and used to derive, for each individual, linear horizontal force–velocity relationships, from which horizontal force– velocity profile (F–V profile), theoretical maximal velocity (V0), horizontal force (F0) and horizontal power (Pmax) were calculated (Samozino, Morin et al., 2013).

Statistical analyses: All parameters were first tested for normality (skewness $-1 < 1$). A one-way ANOVA was used to determine significant differences between groups for the non-skew parameters. All data presented in the results section were normally distributed. Alpha level was set to 0.05.

RESULTS: Elite players were significantly heavier and had a higher BMI compared to the sub-elite players (Table 1). No significant differences were found in height. Elite players had a larger theoretical maximal horizontal velocity (v0) and a higher measure maximal sprint speed (peak horizontal velocity during the 40 m sprint) compared to the sub-elite players. No significant differences in theoretical maximal horizontal force (F0) and horizontal power (Pmax) were observed between the groups.

Table 1. Characteristics of the elite and sub-elite field hockey players.

| | Elite Players | Sub-elite Players |
|--------------------------|---------------|-------------------|
| Weight (kg) | 77 ± 5 | 68 ± 11* |
| Height (cm) | 179 ± 6 | 177 ± 7 |
| BMI (kg/m ²) | 24 ± 1.03 | 21.63 ± 2.96* |
| F0 (N) | 661 ± 76 | 618 ± 109.9 |
| V0 (m/s) | 9.22 ± 0.36 | 8.51 ± 0.47* |
| Maximal velocity (m/s) | 9.03 ± 0.33 | 8.37 ± 0.44* |
| Pmax (Watts/kg) | 19.6 ± 2.6 | 18.85 ± 2.47 |
| Ratio of Force | 65.4 ± 4.8 | 67.0 ± 4.4 |

Data are represented mean ± standard deviation. * Significant difference between the two groups. P<0.05

DISCUSSION: The current study observed a higher theoretical maximal horizontal velocity in elite field hockey players compared to sub-elite player participating in the national league. The present results show for the first time the mechanical determinants of sprint performance in field hockey players. No differences were found in the theoretical maximal horizontal force or maximal power. Results for the theoretical maximal horizontal velocity are similar to what was found in soccer players (Mendiguchia et al., 2014) while the theoretical maximal horizontal force and maximal power seems to be a lot higher in field hockey players compared to the results reported for soccer players (Mendiguchia et al., 2014). Morin et al (2016) reported that in team games with shorter sprints (i.e. acceleration-only phases), the shorter the distance considered, the higher the relationship between sprint performance and horizontal force. The majority of the sprints in field hockey are very short and on average about 10 to 13 meters. Therefore, the lack of difference between elite and sub-elite players

seems to indicate that for these players there is no difference in initial acceleration (up to 10m) performance. Further analysis will have to confirm this hypothesis. It also might be that in the current study the difference in performance between the elite and sub-elite players was minimal or that our sample size was too small to detect these subtle differences.

Within the group of sub-elite players there is clearly a high variability in the different parameters e.g. maximal horizontal force varied between 442N and 853N in the sub-elite group. The force-velocity profile could therefore have high potential to individualize training programs for specific players whereby in players that are below the average group F_0 are recommend to focus on horizontal force output. Further research will need to show the efficacy of this type of individualized training.

We also identified 2 players with a high v_0 and a low F_0 . Looking at the injury history of these players it was clear that they are susceptible for injury. These finding are in line with the previous research of Mendiguchia et al. (2014) who reported that soccer players returning to play after a hamstring injury still have lower F_0 values but normal v_0 .

CONCLUSION: This study showed that elite players had a larger theoretical maximal horizontal velocity compared to sub-elite players. The large variability in the different parameters could potentially be a target for individualized training programs in field hockey players.

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