Relationship between acceleration, horizontal jump ability and strength in young field hockey players

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Summary

The objectives of the present study were, on the one hand, to evaluate the acceleration capacity, horizontal jump and maximum strength in lower limbs in young field hockey players, and on the other, to examine the correlation between the different abilities analyzed. The study design is within a quasi-experimental, cross-sectional approach, the information was collected in a single period of time. 30 players (14.8 ± 1.3 years, 1.74 ± 6.17 m, 65.1 ± 9.9 kg) participated in the study. The results in 10m acceleration had an average of 1.87 ± 0.07 s. In the horizontal jump (SH) an average distance of 2.1 ± .1.7 m was obtained. And finally, the strength results, in the squat, were 94.13 ± 19.11 kg. Medium correlations were observed between strength values with the horizontal jump (r = .309, *P* < .01) and the horizontal jump with acceleration in 10 m (r = -.365, *P* < .01). But no, trivial or low values, between force and acceleration in 10 m (r = .006, *P* < .01). The type, duration and nature of the field tests used determine the correlations observed between the different abilities analyzed, in this particular population.

Key words:
Acceleration. Horizontal jump. Force. Field hockey. Performance.

Relación entre la aceleración, salto horizontal y fuerza en jóvenes jugadores de hockey sobre césped

Resumen

Los objetivos del presente estudio fueron, por un lado, evaluar la capacidad de aceleración, el salto horizontal y la fuerza máxima en miembros inferiores en jóvenes jugadores de hockey sobre césped, y por otro, examinar la correlación existente entre las distintas capacidades analizadas. El diseño del estudio se encuentra dentro de un enfoque cuasi experimental, de corte transversal, la información se recolectó en un único periodo de tiempo. Participaron del estudio 30 jugadores (14,8 ± 1,3 años, 1,74 ± 6,17 m, 65,1 ± 9,9 kg). Los resultados en aceleración 10m tuvieron una media de 1,87 ± 0,07 s. En el salto horizontal (SH) se obtuvo una distancia media de 2,1 ± 1,7 m. Y, por último, los resultados de fuerza, en sentadilla, fueron de 94,13 ± 19,11 kg. Se observaron correlaciones medias entre los valores de fuerza con el salto horizontal (r = 0,309, *p* <0,01) y el salto horizontal con la aceleración en 10 m (r = -0,365, *p* <0,01). Pero no, valores triviales o bajos, entre la fuerza y la aceleración en 10 m (r = 0,006, *p* <0,01). El tipo, la duración y la naturaleza de los test de campo utilizados, condicionan las correlaciones observadas entre las distintas capacidades analizadas, en esta población en particular.

Palabras clave:
Aceleración. Salto horizontal. Fuerza. Hockey sobre césped. Rendimiento.

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Introduction

Field hockey is characterised by numerous high-intensity actions throughout a game, including accelerations, decelerations, changes of direction (COD) and optimal use of the technical resources specific to the sport[1]. The latter actions represent between 12% and 26% of the total game, and carrying them out successfully can determine the final outcome of a match[2]. Strength, speed and technical abilities are crucial aspects in which players must excel to perform at the highest level3. Players must not only improve these abilities but also keep constant control of the ball, change direction quickly and make smooth transitions between walking and sprinting during matches[3]. In order to develop the desired characteristics in players, coaches adapt training programmes and methodologies according to the specific needs of the sport[4]. Therefore, coaches and professionals must constantly work to introduce innovative and improved training methodologies to enhance player capabilities and hone individual skills[5].

The relationship and correlation between different motor skills have been analysed both in team and individual sports[6]. It has been seen that the ability to accelerate and to change direction, and lower limb power are relevant to sports performance[7], these having been defined as significant in most types of sport[8]. So the ability to accelerate in a short distance is extremely important when it comes to performance[9]. As a result, sprint ability can decide the outcome of a game[10]. Strength and power, and the physical feats they afford, are essential to sports performance[10]. Strength, power and the ability to accelerate and jump can mark a difference in performance in matches[11].

Vertical and horizontal jumping are ballistic actions which involve eccentric, isometric and concentric muscle activation. These actions are dependent on the production of force in a time interval (RFD), as represented by the force-time curve, and this sports movement can be represented by a host of values[12].

However, any association between the ability to accelerate and change direction, and strength may be conditioned by the characteristics of the tests used[13]. Furthermore, most of the studies which have analysed the association between different variables, such as acceleration in a straight line, changes in direction, lower limb strength and the ability to jump have been carried out on adult athletes from different sports[14]. Very few studies have analysed and compared such abilities in young people and/or children[8].

So it is important that we obtain reliable information on athletic performance so we can set short-, medium- and long-term objectives, and also for motivational purposes[15]. This information can be gathered using tests that assess physical performance capacity.

The objectives of this study, therefore, were to analyse and correlate the associations that exist between the ability to accelerate in a straight line over 10 m, the ability to jump horizontally and maximum lower limb strength, in squat, in young field hockey players.

Materials and methods

The study design follows a quasi-experimental, cross-sectional approach. The information was collected in a single period. Depending on the scope, it was correlational and descriptive. The study involved 30 field hockey players (15.5 ± 0.5 years of age, 1.74 ± 6.17 m, 65.1 ± 9.9 kg, 23.6) belonging to the 6th category of El Club de Gimnasia y Esgrima de Buenos Aires, a team that competes in La Asociación Amateur de Hockey de Buenos Aires' (AAHBA) Metropolitan Tournament. All the participants had more than 5 years' experience in the sport. They trained an average of 2-3 times a week: 1 endurance session and 1-2 strength sessions. The study was conducted with the consent of the fitness training coordinators and the subcommittee of the club to which they belonged. The procedures followed the guidelines set by the Declaration of Helsinki[16].

Data analysis

The assessments, for the analytical part of this study, were carried out in October during the competitive period while the team was involved in the Metropolitan Tournament. The team attended two assessment sessions. In the first session, weight and height measurements, and a sub-maximal squat test was performed to assess lower body strength. In the second session, 48 hours later, horizontal jump ability (horizontal countermovement jump with hands free) and acceleration over 10 metres were assessed. The acceleration and horizontal jump assessments were conducted on an artificial-turf pitch where the players usually trained and the strength assessment was carried out in a gym. All the players were familiar with the assessments and how to do them properly. Before each session, all the players completed a specific warm-up for each of the assessments: for the strength test, this focused on the core and dynamic stretching, and included a set of bodyweight squats; for the acceleration and horizontal jump tests, it centred on running technique, dynamic stretching and the core, together with accelerations and 3 horizontal jumps to correct errors and explain how to do them correctly.

10-m acceleration test: the acceleration test consisted of 3 maximal sprints over 10 m, with a 3-minute break between each repetition[17]. The players started at 0.5 m from the photocells. Their times were recorded using 4 photocells (Winlaborat ®, Argentina) with a precision of ± 0.001 set at 0.84 m above the ground at the 0 and 10 m marks.

Horizontal jump test (HJ): the players completed 3 horizontal countermovement jumps with free use of the arms[18], taking the best reading for analysis. The distance from the starting point to the landing point of the heel of the rearmost foot was measured[18]. The recovery time between each jump was 3 min. Those jumps in which the players lost stability, moved their feet or rested their hands on the ground were not considered valid.

Maximal strength test: the one-repetition maximum (1RM) was calculated in the half-squat exercise using the Epley formula[19]: (1+0.0333 x reps) x weight, a reliable formula when the number of repetitions is equal

to or less than 10[20]. The players had to perform the maximum number of repetitions possible with a weight with which it was estimated that they could do 6 repetitions.

The players carried out a full knee extension movement. A successful attempt was defined as the ability to move the weight throughout the range of motion in a controlled manner without compensatory movements[21]. If the subjects were able to extend the knees without fatigue or complaints, the load was increased by 0.5 kg up to the heaviest amount they were able to lift. The test ended when the participants were unable to lift the weight with full knee extension due to complaints of fatigue, pain or something else[21], particularly as a result of poor technical execution.

Statistical analysis

The results were presented as mean and standard deviation (SD) with a 95% confidence interval (CI). The Kolmogorov-Smirnov test was used to analyse the normality of the data. Pearson's parametric correlation method (*r*) was used to identify the correlations between the abilities analysed. Established values were used to interpret the results obtained in these correlations: low ($r \leq 0.3$), moderate ($0.3 < r \leq 0.7$) and high ($r > 0.7$)[21]. The statistical analysis was carried out with InfoStat (InfoStat®, version 2020, Cordoba, Argentina). Statistical significance was $P < 0.05$.

Results

Table 1 shows the results obtained (mean ± SD) by field hockey players (n = 30) in the different tests.

Table 2 shows the correlations and interpretation values between the different performance variables analysed.

Moderate correlations were observed between strength values and horizontal jump ability ($r = 0.309$, $P < 0.01$) (Figure 1), and horizontal jump ability and acceleration over 10 m ($r = -0.365$, $P < 0.01$) (Figure 2).

No significant correlation was seen between the strength test values and acceleration over 10 m ($r = 0.006$, $P < 0.01$) (Figure 3).

Table 1. Results of the 10-m acceleration, horizontal jump and maximal strength tests.

	Mean ± SD	Minimum	Maximum
10-m acceleration (s)	1.87 + 0.07	2.037	1.728
Horizontal jump (m)	2.1 + 0.17	1.82	2.48
Maximal strength (kg)	94.13 + 15.36	70	130

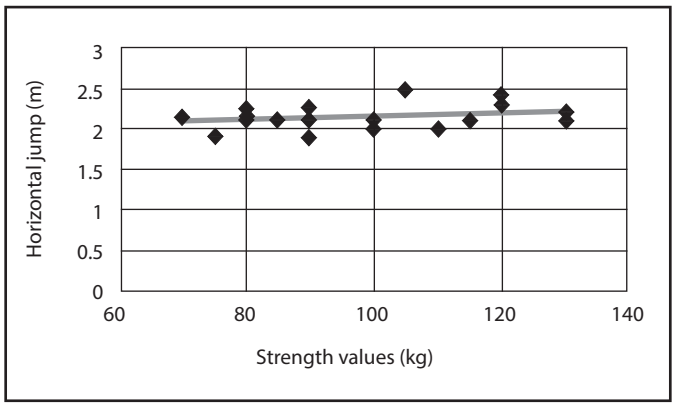
SD: standard deviation; m: metres; s: seconds; kg: kilograms.

Table 2. Correlation coefficients (r), statistical significance (*P*) and interpretation values between the different performance variables (n = 30).

Variables	*r*	*P*	Values
Strength - HJ	0.309	*P* = 0.01	Moderate
HJ - 10-m acceleration	-0.365	*P* = 0.01	Moderate
Strength - 10-m acceleration	0.006	*P* = 0.01	Low

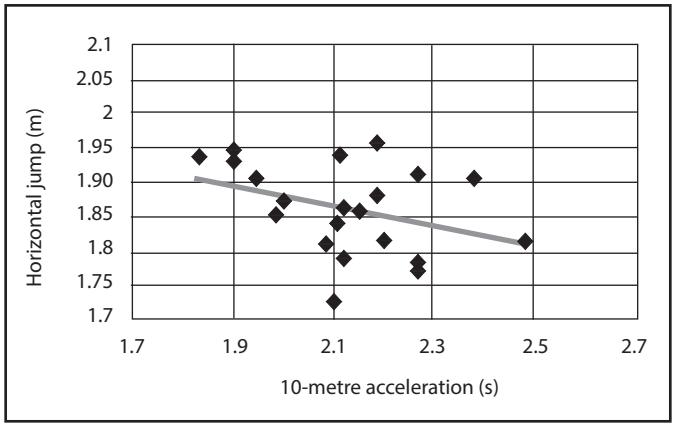
HJ: horizontal jump; m: metres; r: Pearson correlation coefficient; p: statistical significance.

Figure 1. Correlation between strength and horizontal jump values.



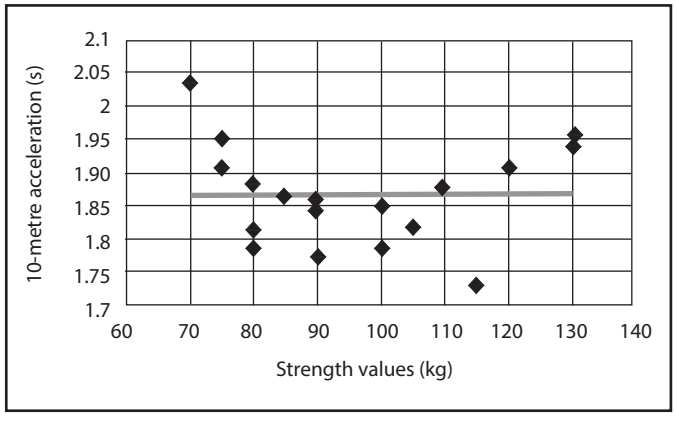
m: metres; kg: kilograms

Figure 2. Correlation between horizontal jump and 10-m acceleration values.



m: metres; s: seconds

Figure 3. Correlation between strength and 10-m acceleration values.



s: seconds; kg: kilograms

Discussion

To date, we have not found any scientific articles analysing correlations between these factors in young field hockey players, so the results obtained may prove to be very important and helpful for fitness coaches working with players of these ages. We have, however, found research focussing on other sports, particularly football[22,23].

The correlations between the distance of the horizontal jump and acceleration over 10 m (r = -0.365, P <0.01) and lower-limb strength and horizontal jump ability (r = 0.309, P <0.01) revealed moderate relationships between each pair. By contrast, no significant relationship was found between strength and acceleration over 10 m (r = 0.006, P <0.01). This suggests that stronger players generate greater force on the horizontal vector (horizontal jumping) and those able to jump a longer distance are able to accelerate more over 10 m. For this reason, it may be a good idea to include specific strength and horizontal jump training in training routines in order to discover their reproducibility in performance, specifically in the ability to accelerate and change direction in young field hockey players.

The relationship found between the ability to jump horizontally and to accelerate concur with previous research, underscoring their importance in sports performance[24]. The ability to generate force on the horizontal axis has been linked to greater agility, which could be relevant in a sport such as field hockey, which is characterised by intense actions and intermittent changes of direction[17]. It has been claimed that acceleration ability is influenced by both vertical and horizontal jump ability because running in a straight line is the result of the forces on both axes[25]. Our figures also agree with the values and correlation analysed by Yanci, *et al.*[26], where the subjects were 39 football players who competed in the Spanish 3rd division (22.9 ± 2.8 years of age, 179.9 ± 6.01 cm, 77.0 ± 8.3 kg), (r = -0.69, moderate, P <0.01); and also with the data gathered by Asier, *et al.*[27], where 34 football players (16.03 ± 1.22 years of age, 1.73 ± 0.07 m, 66.86 ± 7.65 kg, 22.21 ± 1.91 kg/m^2) (r = -0.501, P <0.01) were assessed. However, such strong correlations as those found in studies like that of Irigoyen, *et al.*[28], in which 18 semi-professional football players (25.6 ± 4.8 years of age; 1.82 ± 0.1 m; 77.9 ± 7.1 kg; 23.6 ± 1.8 kg/m^2) belonging to a team that played in the Second Division B of the Professional Football League (LFP) took part, were not obtained. (r = -0.749; P <0.01).

The strength values agree with those found by González-Millán *et al.*[29], in which young footballers (20.9 ± 0.4 years of age; height 180 ± 5.3 cm; 72.3 ± 3.3 kg; 10.5 ± 0.5 years of training) were assessed and analysed. In this regard, some authors affirm that maximal strength is the variable that most influences performance in terms of power[30].

In a meta-analysis[31] of 34 studies involving 1,396 young footballers, it was found that strength training, plyometric training or a combination of both led to improvements in strength, countermovement jumping, horizontal jumping, acceleration and speed (P <0.05; g = 0.73-1.08, moderate).

The limitations of this study could be that only players in the same division and of the same age were assessed, so it may be inappropriate to apply the results to players competing at different levels, such as older and/or younger players, or athletes playing in different contexts, in terms of material and human resources, among others, where the results could prove to be different. It needs to be borne in mind that the participants were assessed at a critical moment in their development: peak growth. Likewise, since correlations do not imply cause and effect, the results of this study need to be approached with caution.

Therefore, it would be interesting to replicate the study using execution speed to monitor strength training and 1RM value assessment.

In future studies, it may be interesting to analyse the effects that specific horizontal jump or plyometric training have on acceleration ability, or vice versa, and those that enhanced strength have on horizontal jumping and acceleration in young field hockey players.

Increasing the population and age of the participants (older and younger categories) could lend greater certainty to the results found in this study.

Conclusions

The results of this study determined a medium correlation between strength values, obtained in squat, and horizontal jump values, and horizontal jump values and the 10-m acceleration test. This suggests that horizontal force may be more involved in the early phases of acceleration. However, no relationship was found between the strength and acceleration values, which makes us think that these characteristics are independent of each other. These findings could be useful for coaches to think about and schedule specific workouts aimed at optimising physical performance in young field hockey players.

Conflict of interest

The author declares no conflict of interest.

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