

Relationships between Pick-up Acceleration, Isometric, and Jump Force-Time Variables in Youth Football Players

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ABSTRACT
The primary aim of the study was to examine the relationships between isometric and jump performance variables and PUA performance. The secondary aim was to establish which combination of these variables can best explain the variance in PUA performance. Twenty-one male youth football players (mean $\pm$ SD, aged 16.7 ± 1.2 , body mass 70.2 ± 9.1 kg) participated in the study. Isometric strength was assessed using the isometric midthigh pull (IMTP) test. Jump performance was assessed using the countermovement rebound jump (CMRJ). PUA was assessed using 20% and 40% of the group's average V_{max} as entry velocities prior to a maximal 20m acceleration. The strongest correlations were found between F100 and PUA performance ($r = -0.516$ and -0.458); only JH1 showed significant correlations with PUA_{20%} performance ($r = -0.389$). F100 was the only variable able to explain 27% and 21% of variance in PUA_{2m/s} and PUA_{4m/s} performance, respectively. Early-phase isometric strength is the most significant variable determining PUA performance in youth footballers. Strength and conditioning coaches should prioritise early-phase strength development to develop PUA.

INTRODUCTION
Enhancing sprint performance is essential to football, as sprinting is strongly linked to decisive moments preceding goals, assists, and defensive efforts. Many studies on strength and sprint performance compare strength variables to results from a static start sprint assessment; however, current evidence suggests that using these assessment methods to explain acceleration performance in football may be inappropriate. Recent studies highlight that static start or low-velocity sprints account for less than 1% of all sprinting activities in a match, while sprinting actions initiated from a moving start are the most common. This independent action is known as pick-up acceleration (PUA), and no studies have been conducted to investigate its underlying strength properties yet. The primary goal of the study was to look at the links between isometric and jump performance factors and PUA performance. The secondary goal was to determine which combination of these variables best explains the variation in PUA performance.

METHODS
21 youth footballers aged 16.7 ± 1.2 (70.2 ± 9.1 kg) who met the inclusion criteria volunteered for this study. Body mass and ground reaction force data from the countermovement rebound jump (CMRJ) and isometric mid-thigh pull (IMTP) tests were collected using VALD ForceDecks sampling at 1000 Hz. PUA was assessed using an adapted method from Pryer et al. (2025). The assessment was performed on an indoor artificial turf pitch. During the test, the participants had to run through a 20m steady-velocity approach zone, matching the speed of a pacer running at either 2 m/s (PUA_{2m/s}) or 4 m/s (PUA_{4m/s}), followed by a maximal acceleration for 20m (Figure 1). Pearson's correlation coefficients (r) were used to analyze the relationship between PUA split times, IMTP, and CMRJ measures. A stepwise regression analysis was undertaken with PUA split times as the dependent variables and force-time measures from both the IMTP and CMRJ as potential predictors.

RESULTS & DISCUSSION
Isometric explosive strength, measured by force at 100 ms (F100) during the IMTP test, was the only significant variable explaining 27% and 21% of total PUA performance variance at entry velocities of 2 m/s and 4 m/s, respectively, in youth football players.

The findings (Table 1) reveal moderate correlations between early-phase force (≤ 200 ms) generation, PF, CMJ height, and PUA performance, with F100 being the strongest predictor, underscoring the importance of rate of force development (RFD). This highlights the unique demands of PUA, where athletes start at higher velocities, experience shorter ground contact times (GCTs), and require greater vertical propulsion. Rapid force generation is crucial, as there is little time for maximal strength to contribute, while increased momentum is vital to accelerate. Interestingly, RSI showed no significant relationship with PUA, possibly due to the population studied. The contact times during rebound jumps ranged from 160 to 290 ms, rendering RSI an unreliable measure of stretch-shortening cycle (SSC) performance in untrained youth athletes. A substantial portion of variance (73-79%) in PUA performance remains unexplained, with no other strength variables significantly contributing to the model. This may result from the diverse physical abilities within the sample and the limited sample size, which impacted statistical power.

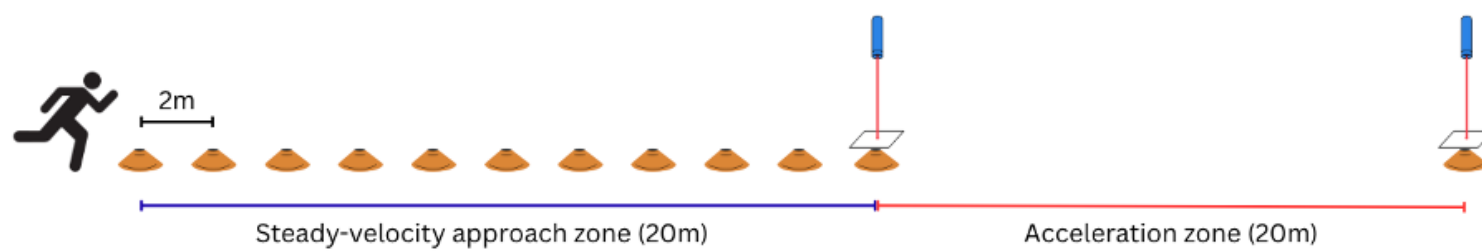


Figure 1. Pick-up acceleration assessment setup

Variable	PUA2m/s	PUA4m/s
PF [N]	-0.402	-0.454
F100 [N]	-0.516	-0.458
F150 [N]	-0.478	-0.444
F200 [N]	-0.468	-0.398
IP150 [Ns]	-0.391	-0.396
IP200 [Ns]	-0.441	-0.436
Rel. F100 [N]	-	-0.39
Rel. F150 [N]	-	-0.397
JH1 [cm]	-0.389	-

Table 1. Variables with significant ($p < 0.05$) correlations (Pearson's r) with two pick-up acceleration conditions.

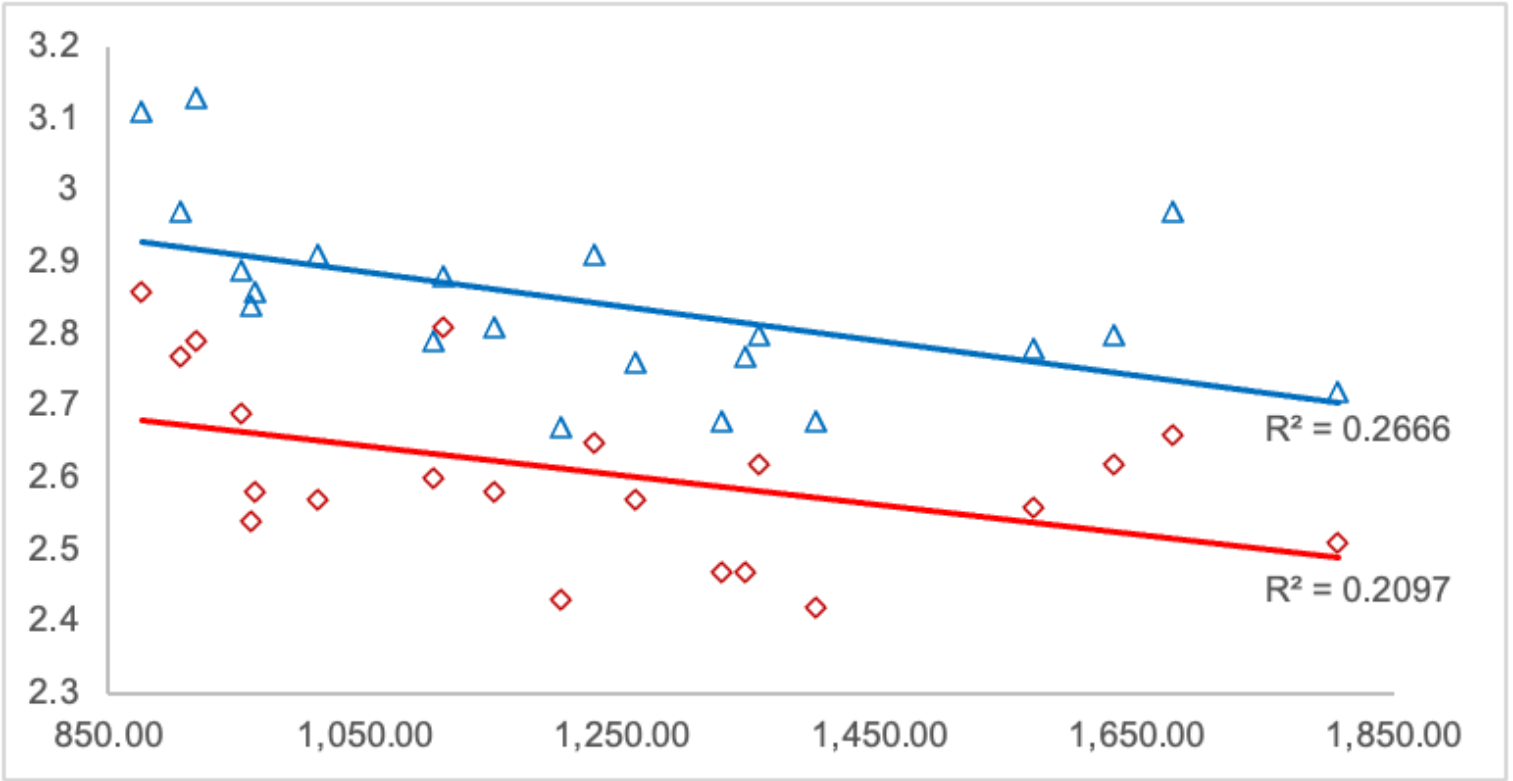


Figure 2. Correlation of force at 100 ms from the isometric midthigh pull and pick-up acceleration performance with 2m/s (blue) and 4m/s (red) entry velocity.

Future research should investigate dynamic strength relationships with PUA performance and focus on populations with more advanced plyometric training.