Both vertical and horizontal plyometric training influence sprint force-velocity profile in young elite soccer players.

Florian Norgeot, Alexandre Fouré

BOTH VERTICAL AND HORIZONTAL PLYOMETRIC TRAINING INFLUENCE SPRINT FORCE-VELOCITY PROFILE IN YOUNG ELITE SOCCER PLAYERS

Florian NORGEOT[1,2] & Alexandre FOURÉ[1,*]

[1]Université Claude Bernard Lyon 1, Laboratoire Interuniversitaire de Biologie de la Motricité (LIBM), UR7424, Villeurbanne, France.
[2]Football Bourg-en-Bresse Péronnas 01, Péronnas, France.
*alexandre.foure@univ-lyon1.fr

Get the pdf version of the poster!

Introduction

During a soccer match, sprint horizontal acceleration ability is determinant for performance. Development of sprint force and velocity qualities has been reported after plyometric training (Barrera-Dominguez *et al.* 2023).

However, the orientation of plyometric training exercises can influence functional performances (Dello Iacono *et al.* 2017). The force-velocity profile (FVP) can be of great interest to assess the plyometric training-induced effects on the changes in performance and athletes' behavior during a linear sprint (Watkins *et al.*, 2021). Nevertheless, a comparison between horizontal and vertical plyometric training on sprint FVP has yet to be conducted.

The purpose of the present study was to **evaluate and compare the effects of 8-week horizontal and vertical plyometric training on explosiveness performance and sprint force-velocity profile in young soccer players**

Methods

- **Population:** Twenty-eight soccer players (age: 30 ± 6 y, height: 169 ± 9 cm, mass: 65 ± 12 kg) divided in a vertical (n = 14) and a horizontal (n = 14) group.

- **Training protocol:** 2000 contacts |16 session (2 sessions/wk) (Table 1)

- **Jump performances:** Vertical and horizontal jumps including: squat jump (SJ), counter-movement jump (CMJ) and drop jump 30 cm (DJ) | Optojump and *MyJump* app.

- **Sprint FVP:** Linear 30 m sprint – Times at 5, 10, 15 and 30 m | *MySpring* app. From the F-V relationship modeling of the 30 m sprint: maximal force (F_0), maximal velocity (V_0), maximal power (P_{max}), maximal ratio of force (RF_{max}) and the decrease rate in RF with increasing speed (DRF) (Samozino *et al.*, 2022).

- **Statistical analysis**: 2-way ANOVA (time [PRE – POST] * group [VG – HG]) for all the variables (Tukey HSD post-hoc test in case of interaction) | Student t-test for the time effect in each group.

Week	Session	Vertical group (n = 14)	Horizontal group (n = 14)
1	1	8 x 5 bilateral HJ (15cm) | 8 x 5 CMJ	8 x 5 bouncing strides (free) | 8 x 5 lateral jumps (free)
	2	8 x 5 bilateral HJ (15cm) | 8 x 5 CMJ	8 x 5 bouncing strides (120cm) | 8 x 5 lateral jumps (90cm)
2	3	8 x 5 bilateral HJ (15cm) | 8 x 5 CMJ	8 x 5 bouncing strides (120cm) | 8 x 5 lateral jumps (100cm)
	4	10 x 4 unilateral HJ (15cm) | 10 x 4 CMJ	10 x 4 bouncing strides (140cm) | 10 x 4 unilateral strides (90cm)
3	5	10 x 4 unilateral HJ (15cm) | 10 x 4 CMJ	10 x 4 bouncing strides (free) | 10 x 4 unilateral strides (free)
	6	10 x 4 bilateral HJ (15cm) | 10 x 4 CMJ	10 x 4 bouncing strides (140cm) | 10 x 4 lateral jumps (100cm)
4	7	10 x 6 unilateral HJ (15cm) | 10 x 6 CMJ	10 x 6 bouncing strides (140cm) | 10 x 6 unilateral strides (120cm)
	8	10 x 6 bilateral HJ (30cm) | 10 x 6 CMJ	10 x 6 bouncing strides (180cm) | 10 x 6 lateral jumps (120cm)
5	9	10 x 7 unilateral HJ (30cm) | 10 x 7 CMJ	10 x 7 bouncing strides (180cm) | 10 x 7 unilateral strides (130cm)
	10	10 x 7 unilateral HJ (30cm) | 10 x 7 CMJ	10 x 7 bouncing strides (210cm) | 10 x 7 unilateral strides (free)
6	11	10 x 7 bilateral HJ (30cm) | 10 x 7 CMJ	10 x 7 unilateral strides (140cm) | 10 x 7 lateral jumps (140cm)
	12	10 x 8 unilateral HJ (30cm) | 10 x 8 CMJ	10 x 8 bouncing strides (240cm) | 10 x 8 unilateral strides (free)
7	13	10 x 8 unilateral HJ (30cm) | 10 x 8 CMJ	10 x 8 bouncing strides (240cm) | 10 x 8 unilateral strides (150cm)
	14	10 x 8 bilateral HJ (45cm) | 10 x 8 CMJ	10 x 8 bouncing strides (240cm) | 10 x 8 lateral jumps (140cm)
8	15	10 x 9 bilateral HJ (45cm) | 10 x 9 CMJ	10 x 9 bouncing strides (240cm) | 10 x 9 lateral jumps (140cm)
	16	10 x 10 unilateral HJ (45cm) | 10 x 10 CMJ	10 x 10 bouncing strides (270cm) | 10 x 10 lateral jumps (180cm)
Total		**2000 contacts** (27% unilateral)	**2000 contacts** (72% anterior | 28% lateral)

Table 1: Plyometric training in vertical and horizontal groups. Data are expressed as number of contacts (series × jumps) and intensity are displayed between parentheses (jump height [for vertical group] or length [for horizontal group] in centimeters). Unilateral jumps were made on a single leg (and repeated on the other). *HJ: hurdle jump, CMJ: counter movement jump.*

Results

	Group	Pre-test	Post-test	Statistical effects	
SJ (cm)	VG	31.1 ± 6.3	33.5 ± 5.1[a]	*Time effect* η^2_p = 0.623, p = 0.001	p = 0.001 | d = 0.410
	HG	29.8 ± 3.0	32.7 ± 2.8[a]		p = 0.001 | d = 0.994
CMJ (cm)	VG	32.5 ± 5.8	33.9 ± 5.3[a]	*Time effect* η^2_p = 0.333, p = 0.001	p = 0.025 | d = 0.254
	HG	31.1 ± 3.2	32.9 ± 3.2[a]		p = 0.005 | d = 0.548
DJ (cm)	VG	33.7 ± 6.2	37.0 ± 5.2[a]	*Time effect* η^2_p = 0.348, p = 0.001	p = 0.009 | d = 0.557
	HG	33.6 ± 4.6	35.9 ± 3.9[a]		p = 0.010 | d = 0.532
V_0 (m/s)	VG	8.30 ± 0.81	8.47 ± 0.60	*ns*	/
	HG	8.30 ± 0.64	8.33 ± 0.41		/
F_0 (N/kg)	VG	6.51 ± 0.82	7.36 ± 0.67	*Time effect* η^2_p = 0.546, p = 0.001	p = 0.003 | d = 1.135
	HG	6.33 ± 0.86	8.01 ± 1.29		p = 0.001 | d = 1.532
P_{max} (W/kg)	VG	13.43 ± 1.53	15.57 ± 1.73	*Time effect* η^2_p = 0.703, p = 0.001	p = 0.001 | d = 1.310
	HG	13.09 ± 1.71	16.63 ± 2.40		p = 0.001 | d = 1.699
RF_{max} (%)	VG	46.79 ± 2.64	50.14 ± 2.54	*Time*Group interaction* η^2_p = 0.157, p = 0.037	p = 0.006 | d = 1.293
	HG	46.14 ± 2.68	52.36 ± 3.10		p = 0.001 | d = 2.147
DRF	VG	-0.078 ± 0.010	-0.083 ± 0.009	*Time effect* η^2_p = 0.352, p = 0.001	*ns*
	HG	-0.075 ± 0.011	-0.091 ± 0.016		p = 0.001 | d = 1.166

Table 2: Vertical jump performances and 30 m sprint force-velocity profile parameters evaluated before (Pre-test) and after (Post-test) the 8-week plyometric training for the vertical (VG) and horizontal (HG) groups. [a]: Significantly different from Pre-test (p < 0.05), η^2_p: partial eta squared (ANOVA main effect), d: Cohen's d (from Student t-test), *ns*: non-significant. *SJ: squat jump, CMJ: counter-movement jump, DJ: drop jump, V_0: maximal velocity, F_0: maximal force, P_{max}: the maximal power, RF_{max}: the maximal force ratio, DRF: the decrease rate in RF with increasing speed*

- Significant changes in both VG and HG were observed in vertical performances after the plyometric training (p > 0.05, Table 2).

- Significant differences in horizontal jumps, sprint performances and FVP parameters relative changes between VG and HG were also found (p < 0.05, Figure 1).

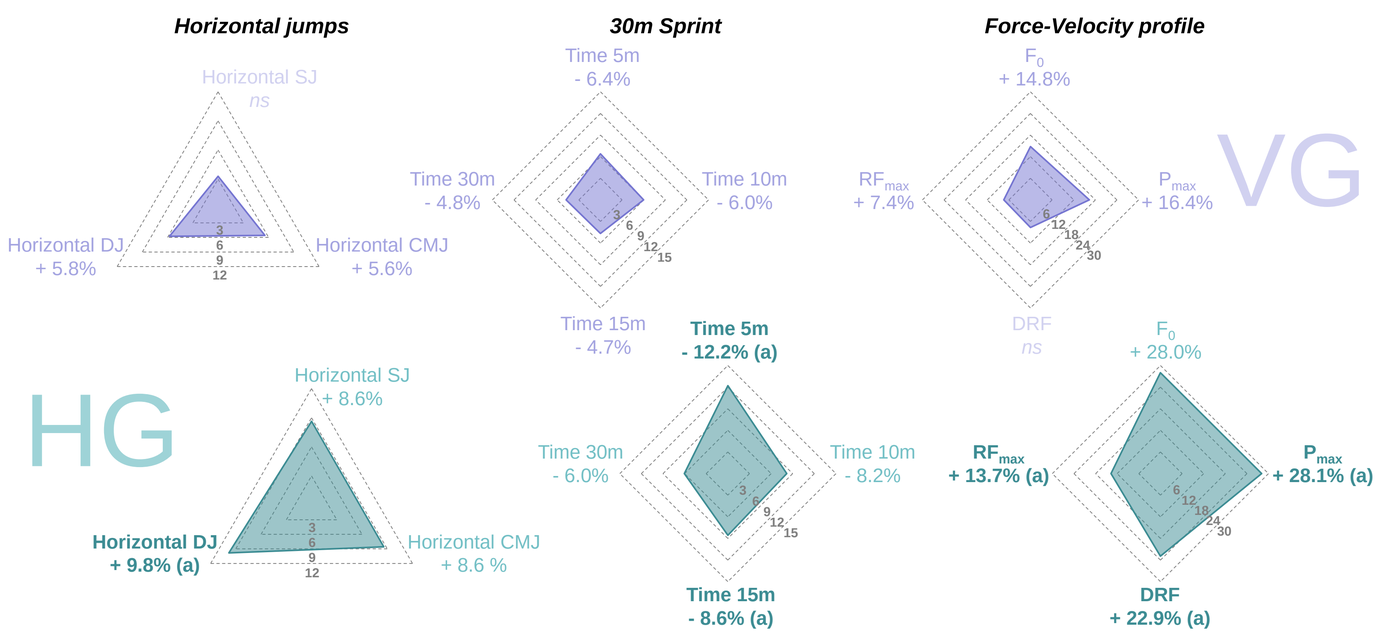

Figure 1: Significant mean relative changes between pre- and post-tests for the vertical group (VG) and the horizontal group (HG) in horizontal jump performances (squat jump [SJ], counter-movement jump [CMJ] and drop jump [DJ]), sprint performances (sprint time at 5m, 10m, 15m and 30m) and force-velocity profile parameters (including the maximal force [F_0], the maximal power [P_{max}], the maximal force ratio [RF_{max}] and the decrease rate in RF with increasing speed [DRF]). *ns: no significant changes in vertical group or horizontal group, a: significant difference between relative changes assessed in VG and HG (p < 0.05).*

Discussion

Both horizontal and vertical plyometric training can be either used in young soccer players to improve vertical and horizontal performances in jump and sprint as previously reported (Ramirez-Campillo *et al.*, 2015). However, horizontal plyometric training may give a larger gain in horizontal ballistic actions while developing vertical jump qualities in young soccer players.

Further studies are necessary to more deeply compare motor coordination and muscular synergies involved in vertical and horizontal actions and potential specific effects on musculoskeletal structural adaptations. Additionally, the comparison of directions (*i.e.*, lateral and anterior) of horizontal plyometric exercises needs to be further investigated.

References

Barrera-Dominguez *et al.* (2023) Eur J Sport Sci, 23(12):2379-2388.
Dello Iacono *et al.* (2017) J Strength Cond Res, 31(4):921-931.
Watkins *et al.* (2021) J Strength Cond Res, 35(3):604-615.
Samozino *et al.* (2022) Scand J Med Sci Sports, 32(3):559-575.
Ramirez-Campillo *et al.* (2015) J Strength Cond Res, 29(7):1784-95.

ECSS GLASGOW 2024

F. NORGEOT A. FOURÉ