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The use of horizontal force-velocity profile in soccer: a rapid systematic review

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Abstract

Background The ability to accelerate and reach high sprinting velocities is crucial to soccer performance. In this context, the horizontal force-velocity profile (H-FVP) has emerged as a tool to evaluate neuromuscular capabilities relevant to sprinting. This rapid review aims to critically describe the application of H-FVP in soccer and summarize the characteristics of the methodologies employed in its measurement and calculation.

Methods A rapid systematic review was conducted in accordance with the Cochrane Rapid Reviews Guidance and PRISMA guidelines. A search on MEDLINE (via PubMed), SPORTDiscus (via EBSCOhost), and Web of Science databases was conducted in February 2025. Studies were considered eligible if they assessed the H-FVP in soccer players of any competitive level and both sexes.

Results Fourteen studies met the inclusion criteria, analysing a total of 1320 soccer players across different competitive levels. Most studies explored the relationship between H-FVP parameters and sprint or change of direction performance. Additional studies addressed variations according to playing position differences, biological maturation, fatigue responses, or injury profile. The predominant testing protocols involved linear sprints ranging from 30 to 40 m, often with split-distance measurements. The Samozino method was consistently used for H-FVP computation. Commonly reported parameters included theoretical maximal force (F_0), velocity (V_0), and power (P_{max}), with some studies also including the ratio of force (RF) and its decrease with speed (DRF). Radar devices, photocell systems and mobile applications were the primary measurement tools utilized.

Conclusion This systematic review highlights the potential of the H-FVP as an approach to be used to improve sprint performance in soccer players across competitive levels. However, methodological inconsistencies among studies highlight the need for standardized testing protocols to improve their practical application. Identified gaps in the literature point out the necessity for further investigation in future research.

Keywords Acceleration, Football, FVP, Performance, Soccer, Sprint

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Background

Understanding the mechanical factors that influence sprinting performance is important in soccer, where acceleration and sprint speed often influence match-defining moments [1]. Force-velocity profiling (FVP) has emerged as a method for evaluating athletes' neuromuscular capabilities by analyzing the relationship between force and velocity during different multi-joint tasks, such as vertical jumps and sprints [1, 2]. Specifically, the horizontal force-volocity profile (H-FVP) describes the relationship between the horizontal force an athlete can produce and their corresponding running velocity. By plotting force against velocity across different sprint phases, practitioners can determine whether an athlete is more force or velocity oriented, thereby enabling individualized and targeted training interventions [2]. By analysing this relationship, H-FVP provides important information about the athlete's mechanical ability to generate force, power and velocity, factors directly related to sprint performance and injury prevention [3].

In recent years, the use of FVP in soccer has gained increasing attention from researchers and practitioners due to its capacity to provide a more comprehensive assessment of sprint mechanics compared to traditional methods, which typically rely on sprint times over fixed distances [3, 4]. The H-FVP quantifies essential mechanical variables including the theoretical values of force (F0), velocity (V0) and power (Pmax), along with the effectiveness of force application in the anterior-posterior direction (RF) and the rate of decrease in the ratio of horizontal force as the velocity increases (DRF) [3, 5]. These parameters support individualised training interventions focused on optimising sprint performance and reducing injury risk [3, 5].

Technological advancements, such as radar timing systems, laser devices and high-speed video analysis, have facilitated the practical application of H-FVP in soccer settings [6]. The Samozino method, for instance, allows practitioners to calculate H-FVP using simple anthropometrical data and velocity measurements obtained from global positioning system (GPS) units, accelerometers, or laser-based systems [7]. In practice, athletes perform a maximal sprint (e.g., 30 m) with timing gates at fixed intervals (e.g., 10 m, 20 m, 30 m), from which instantaneous velocity and acceleration are estimated. These values are used to model the force-velocity relationship and derive key mechanical outputs (F0, V0 and Pmax), along with secondary metrics (RF, DRF). This field-friendly approach has been validated against force-plate measurements and is widely adopted due to its accessibility, minimal equipment demands and reliable results [2]. As a result, FVP has become more accessible, allowing coaches and sports scientists to incorporate the outcomes into FVP calculation in training programs [8].

Despite its increasing interest, the use of H-FVP in soccer lacks a comprehensive synthesis of the methods and their practical applications [9]. While H-FVP has been explored across various team sports [10], no systematic synthesis has yet investigated its specific applications, testing methods and outcomes in soccer. As physical testing methods evolve rapidly in elite sport, practitioners need evidence-based recommendations that can be implemented within a single competitive season. In this context, a rapid systematic review, conducted according to Cochrane Rapid Review and PRISMA guidelines, can provide an actionable evidence synthesis within a short time compared to the long process typical of traditional reviews [11]. Therefore, this rapid systematic review aims to critically describe the application of the H-FVP in soccer and summarize the characteristics of the methodologies employed in its measurement and calculation.

Materials and methods

The study used a rapid review methodology to expedite the traditional systematic review process while maintaining methodological rigor. Rapid reviews are particularly suited for expediting knowledge translation, making them ideal for identifying measurement methods for the H-FVP in soccer and exploring its practical applications for performance enhancement. The review was conducted in accordance with the Cochrane Rapid Reviews Guidance [11] and adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) (see in online Supplementary material 1) guidelines [12].

Search and eligibility criteria

A search was conducted in the electronic databases MEDLINE (via PubMed), SPORTDiscus (via EBSCOhost) and Web of Science. The inclusion criteria were established based on the PECOS framework: Participants/Population (P): male and female soccer players at all competitive levels; Exposure (E): studies assessing the H-FVP or investigating its application in soccer performance; Comparator (C): not required, as a non-comparative designs was necessary; Outcomes (O): data on H-FPV parameters and mechanical variables (e.g., F_0, V_0, P_{max}, RF, DRF); Study design (S): observational (cross-sectional, cohort), quasi-experimental and experimental designs.

The search strategy incorporated Boolean operators and the following keywords: ("football" OR "soccer") AND ("Force-velocity profile" OR "force-velocity profiling" OR "horizontal force-velocity profile" OR "F-V profile" OR "FVP"). Studies were excluded if they did not measure or report the outcomes, focused on populations outside the scope of the review (e.g., para-athletes, clinical patients, or athletes from other sports modalities), or literature reviews, reports and conference abstracts. Additionally, studies published in languages other than English or those in which H-FVP was examined only as a secondary outcome rather than a primary research focus were excluded. Studies where H-FVP was reported only as a secondary outcome. It should be acknowledged, however, that while ensuring methodological consistency and data comparability, this may have led to the exclusion of potentially informative findings from studies where H-FVP was measured incidentally.

The search was limited to studies published between January 1st, 2010 and February 28th, 2025. Reference lists of included studies were manually screened for additional relevant articles (citation tracking). A complementary search in grey literature, including Google Scholar, was also conducted to identify potentially overlooked sources.

Study selection and data extraction

All retrieved articles were imported into *Rayyan* systematic review software [13]. The selection proceeded in the following steps: (i) identification and removal of duplicate records; (ii) exclusion of studies with designs outside the predefined eligibility criteria and foreign languages; (iii) screening of titles and abstracts; (iv) full-text evaluation and data extraction. Two independent reviewers conducted the selection and extraction process. Discrepancies were solved by consultation with the third reviewer.

Data extraction was conducted using a customised Excel spreadsheet (Microsoft Corporation, Redmond, Washington, USA). Extracted variables included: study characteristics (authors, year, country); participant demographics (age, sex, competitive level); methodological approach to H-FVP measurement; reported H-FVP parameters (F0, V0, Pmax). To standardise the competitive level of the players, the authors opted for using McKay's six-tier Participant Classification Framework: Tier 5 = world-class, Tier 4 = elite/international, Tier 3 = professional/national, Tier 2 = semi-professional/developmental, Tier 1 = recreational, Tier 0 = sedentary [14]. Mixed cohorts were assigned a median tier; if classification was unclear, the label "information insufficient" was used.

Only H-FVP-related outcomes were extracted; vertical FVP data were excluded. In cases where data were missing or presented graphically, the corresponding authors were contacted. The study selection process is summarized in the PRISMA flowchart (Fig. 1).

Risk of bias assessment

The methodological quality of included studies was evaluated using the *Risk Of Bias In Non-randomized Studies of Exposures* (ROBINS-E) tool. This tool assesses seven bias domains: (i) confounding; (ii) selection of participants, (iii) classification of exposures, (iv) deviations from intended exposures, (v) missing data, (vi) measurement

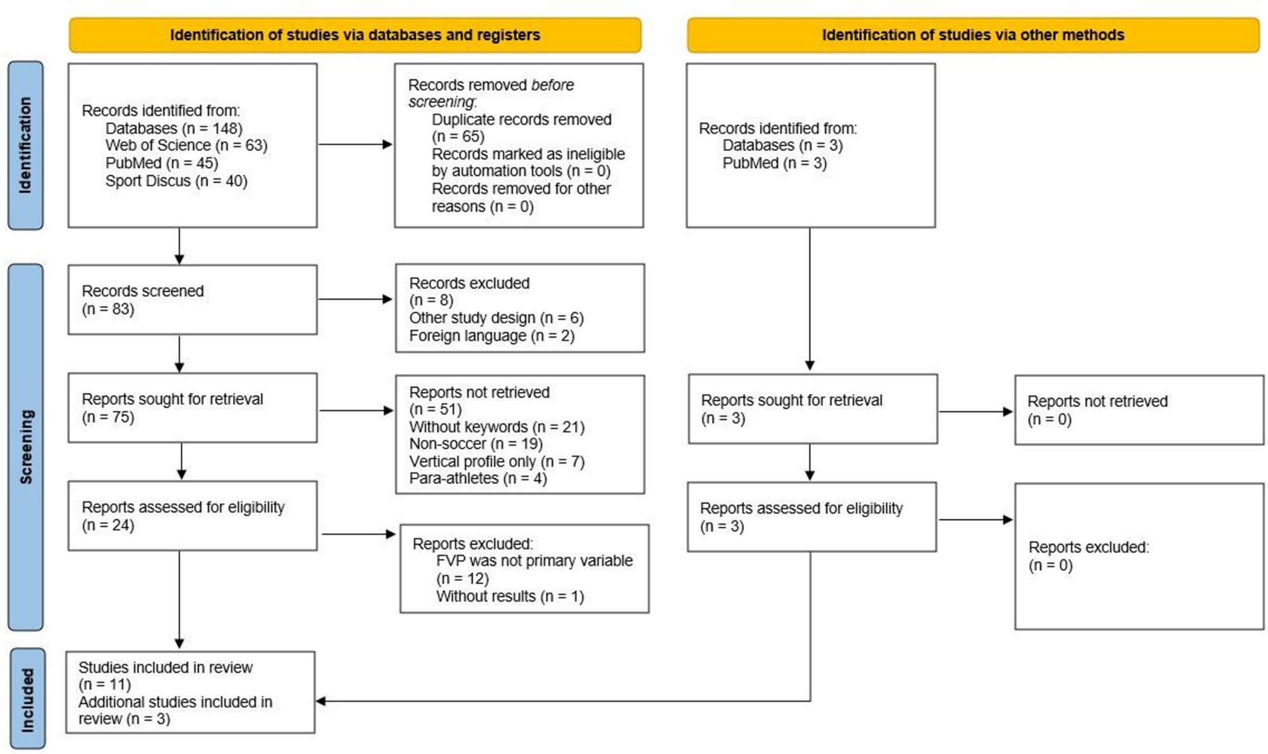

Fig. 1 Flow chart diagram of the study selection process (PRISMA 2020) [12]

of outcomes, and (vii) selection of the reported result. Each domain was rated as: low risk = little or no concern; moderate risk = some concern, not likely to alter results substantially; high risk = major concern affecting credibility; very high risk = severe flaws that compromise findings. The overall risk of bias scores for each study were determined using a "worst-of" approach, where the highest domain-level risk sets the overall score [15, 16]. A summary of the risk of bias assessment is presented in Table 1.

Results

A total of 148 articles were retrieved from the initial database searches. After the removal of 65 duplicates, 83 articles remained for screening. Eight studies were excluded at this stage due to inappropriate research design or being published in a foreign language other than English. The remaining 75 studies were screened based on their titles and abstracts, leading to the exclusion of 51 studies for reasons including lack of relevant keywords, a focus on non-soccer populations (e.g., para-athletes), or examining only the vertical force-velocity profile. Full-text assessment was conducted for the remaining 24 studies, of which 13 were excluded for not considering the H-FVP

Table 1 Risk of Bias assessment (ROBINS-E)

Author (year), country	RoB due to confounding	RoB arising from measurement of the exposure	RoB in selection of participants into the study	RoB due to post-exposure interventions	RoB due to missing data	RoB arising from measurement of the outcome	RoB in selection of the reported result	Overall assessment
Baena-Raya et al. [9] (2021), Spain	High risk	Moderate	Low	Low	Low	Low	Moderate	High risk
Ben Hassen et al. [17] (2023), Tunisia	High risk	Moderate	Low	Low	Low	Moderate	Moderate	High risk
Fernández-Galván et al. [18] (2022), Spain	Moderate	Moderate	Moderate	Low	Low	Low	Moderate	Moderate
Haugen et al. [19] (2020), Norway	High risk	Moderate	Low	Low	Moderate	Low	Moderate	High risk
Hermosilla-Palma et al. [20] (2022), Chile	Low	Moderate	Low	Moderate	Low	Moderate	Moderate	Moderate
Ince et al. [21] (2025), Turkey	High risk	Moderate	Low	Low	Low	Low	Moderate	High risk
Jiménez-Reyes et al. [22] (2019), Spain	High risk	Moderate	Low	Low	Low	Low	Moderate	High risk
Jiménez-Reyes et al. [5] (2022), Spain	High risk	Moderate	Low	Moderate	Moderate	Low	Moderate	High risk
Marcote-Pequeño et al. [23] (2019), Spain	High risk	Moderate	Moderate	Low	Low	Low	Moderate	High risk
Mendiguchia et al. [24] (2016), Spain	Very high risk	Very high risk	Low	Moderate	Low	Low	Moderate	Very high risk
Mitrecic et al. [25] (2025), Croatia	High risk	Moderate	Moderate	Low	Low	Low	Moderate	High risk
Robles-Ruiz et al. [26] (2023), Spain	High risk	Moderate	Low	Low	Low	Low	Moderate	High risk
Sánchez-López et al. [8] (2023), Spain	High risk	Moderate	Low	Low	Low	Low	Moderate	High risk
Zhang et al. [27] (2021), France	High risk	Moderate	Moderate	Low	Low	Low	Moderate	High risk

Note: RoB - Risk of Bias

as a primary outcome or for inadequate reporting. An additional manual search of key journals identified three additional eligible studies, resulting in a final total of 14 studies included in the review (Fig. 1).

Sample characteristics

Across the 14 included studies, a total of 1,320 soccer players (mean age = 21.68 ± 4.74 yrs) were assessed (Table 2). Most of the studies (71.43%, n = 10) focused exclusively on male participants, while one study examined only female players and three included both sexes. Regarding competitive level, the majority of studies investigated Tier 3 (28.5%) and Tier 4 (21.4%) players, and mixed-level cohorts (14.3%). Geographically, most studies were conducted in Europe, with Spain being the most represented country.

H-FVP study topics and main outcomes

The main topic explored in the included studies is summarized in Table 3. Half of the studies (50%) investigated the relationship between H-FVP parameters and sprint-related performance metrics, including acceleration and change of direction (COD). Other frequent topics included positional differences, biological maturation, fatigue responses and injury status. Despite the diversity in study designs and participant profiles, the most frequent outcome involved associations between H-FVP variables and performance indicators such as sprint acceleration and COD ability. Additional insights were reported regarding performance differences by playing position, developmental stage, fatigue-induced performance changes and injury prevention or rehabilitation implications.

Sprint methods, H-FVP parameters and measurement devices

The studies employed different sprint test distances and measurement tools to assess the H-FVP (Table 2). The 30-meter sprint test was the most frequently used protocol (64.29%, n = 9), followed by 40 m (28.57%, n = 4) and 50 m (7.14%, n = 1). Additionally, one study utilized a Repeated Sprint Ability (RSA) test over 30 m. Most studies (71.43%, n = 10) incorporated split-distance measurements, typically at 5, 10, 15 and 20 m; four studies (28.57%) did not report split-distance data. All studies utilized Samozino's method to compute H-FVP parameters.

The majority of studies (71.43%, n = 10) analysed all key H-FVP parameters: F0 (theoretical maximal horizontal force at zero velocity), V0 (theoretical maximal velocity at zero horizontal force), and Pmax (peak mechanical power, calculated as [F0 × V0]/4) and the RF-DRF profile (rate of force decrease) [3]. The remaining four studies focused solely on F0, V0 and Pmax. These values are derived by fitting a mono-exponential velocity–time curve from data collected during maximal sprint efforts.

Regarding measurement devices, the Stalker ATS II radar was the most commonly used tool (50%, n = 7), followed by the MySprint app (21.43%, n = 3) and photocell systems (14.29%, n = 2). Two studies combined multiple devices, including radar, photocells and mobile applications. Different device classes, such as radar and laser-based time-of-flight sensors, Global Navigation Satellite System (GNSS)-inertial sensors and high-speed video analysis, were employed to capture the raw velocity-time data required for F0, V0 and Pmax estimation. While each device varies in sampling rate and precision, all were capable of providing the essential metrics for H-FVP modeling [6, 28].

Assessment of study quality

The methodological quality of the included studies was assessed using the ROBINS-E tool. Overall, 78.6% (n = 11) of the studies were rated as having a high risk of bias. Two studies (14.3%) were categorized as having a moderate risk, while one study (7.1%) was classified as having a very high risk of bias. No studies achieved a rating of low or unclear risk. The domain most frequently rated as high risk was "Risk of Bias due to Confounding," with 11 out of 14 (78.6%) studies assessed as high risk in this domain. This indicates a frequent lack of adequate control for potential confounding variables, which may have influenced the observed associations. On the other hand, two domains demonstrated consistently low risk of bias across studies. Specifically, "Risk of Bias arising from Measurement of the Outcome" and "Risk of Bias due to Missing Data" were each rated as low risk in 12 out of 14 studies (85.7%). This suggests that outcome measures were generally applied consistently and that missing data were either minimal or handled appropriately in most studies. These results highlight prevalent concerns regarding methodological rigor across the available evidence. A detailed breakdown of the individual study assessment is reported in Table 1.

Discussion

This rapid systematic review synthesised current evidence on the application of H-FVP in soccer. The main findings suggest that H-FVP parameters, particularly F_0, V_0 and Pmax, can be related to performance in sprint and COD performance. Variability in these metrics is observed across playing positions, competitive levels and stages of biological maturation. Most studies assessed professional players (Tier 3 and 4) and employed the Samozino method for H-FVP evaluation. Although technological advances have improved the accessibility of H-FVP assessment, discrepancies in testing protocols and device selection remain, highlighting the need for

Table 2 Study players characteristics, test description, and H-FVP determination

Author (year), country	Age (yrs), sex (M, F), sample size (*n*)	Level	Sprint test Distance Reps Split distance	H-FVP parameters	Device	Meth-ods
Baena-Raya et al. [9] (2021), Spain	25.35 ± 3.55 yrs M *n* = 23	Tier 2	Linear sprint 30 m 2 rep 5, 10, 15 and 20 m	F0 V0 Pmax	Stalker ATS II Photocells	Samo-zino
Ben Hassen et al. [17] (2023), Tunisia	17.31 ± 0.45 yrs M *n* = 90	Tier 4	Linear sprint 30 m 2 rep 10 and 20 m	F0 V0 Pmax	MySprint app	Samo-zino
Fernández-Galván et al. [18] (2022), Spain	16.61 ± 2.63 yrs M *n* = 62	Tier 3	Linear sprint 30 m 2 rep 5, 10, 15, 20 and 25 m	F0 V0 Pmax RF DRF	MySprint app	Samo-zino
Haugen et al. [19] (2020), Norway	M: 23.85 ± 4.03 yrs M *n* = 467 F:21.64 ± 4.08 yrs F *n* = 207	Tier 3 Tier 1	Linear sprint 40 m 2 rep 10, 20 and 30 m	F0 V0 Pmax RF DRF	Photocells	Samo-zino
Hermosilla-Palma et al. [20] (2022), Chile	23.5 ± 5.0 yrs M *n* = 17	Tier 3	Linear sprint RSA (30 m) 8 rep 5, 10, 15, 20 and 25 m	F0 V0 Pmax RF DRF	MySprint app	Samo-zino
Ince et al. [21] (2025), Turkey	16.14 ± 0.54 yrs M *n* = 34	Tier 2	Linear sprint 30 m 2 rep 5, 10 and 20 m	F0 V0 Pmax RF DRF	Photocells	Samo-zino
Jiménez-Reyes et al. [22] (2019), Spain	M: 25.57 ± 3.78 yrs M *n* = 73 F: 20.66 ± 3.01 yrs F *n* = 39	Tier 1	Linear sprint 40 m 3 rep 5 and 20 m	F0 V0 Pmax RF DRF	Stalker ATS II	Samo-zino
Jiménez-Reyes et al. [5] (2022), Spain	26.9 ± 3.1 yrs M *n* = 21	Tier 3	Linear sprint 40 m 2 rep -	F0 V0 Pmax RF DRF	Stalker ATS II	Samo-zino
Marcote-Pequeño et al. [23] (2019), Spain	23.4 ± 3.8 yrs F *n* = 19	Tier 4	Linear sprint 30 m 2 rep -	F0 V0 Pmax RF, not explicitly reported DRF	Stalker ATS II	Samo-zino
Mendiguchia et al. [24] (2016), Spain	25 yrs M *n* = 1	Tier 3	Linear sprint 50 m 2 rep 2, 5, 10, 20 and 30 m	F0 V0 Pmax	Stalker ATS II	Samo-zino
Mitrecic et al. [25] (2025), Croatia	22.6 ± 3.7 yrs M *n* = 110	Tier 1	Linear sprint 30 m 2 rep 5, 10, 15, 20 and 25 m	F0 V0 Pmax RF DRF	MySprint app Photocells	Samo-zino

Table 2 (continued)

Author (year), country	Age (yrs), sex (M, F), sample size (*n*)	Level	Sprint test Distance Reps Split distance	H-FVP parameters	Device	Methods
Robles-Ruiz et al. [26] (2023), Spain	21.8 ± 2.99 yrs M *n* = 16	Tier 2	Linear sprint 30 m 2 rep -	F0 V0 Pmax RF DRF	Stalker ATS II	Samozino
Sánchez-López et al. [8] (2023), Spain	19.67 ± 3.32 yrs M *n* = 77	Tier 3 Tier 1	Linear sprint 30 m 3 rep -	F0 V0 Pmax	Stalker ATS II	Samozino
Zhang et al. [27] (2021), France	M: 16.1 ± 0.4 yrs M *n* = 36 F: 17.1 ± 1.6 yrs F *n* = 28	Tier 4	Linear sprint 40 m 3 rep 5, 10, 15 and 20 m	F0 V0 Pmax RF DRF	Stalker ATS II	Samozino

Note: SD - standard deviation; M - male; F - female; ATS - Acceleration Testing System; RSA - Repeated Sprint Ability; F0 - theoretical maximal force; V0 - theoretical maximal velocity; Pmax - maximal power; RF - ratio of horizontal to resultant force; DRF - decrease in the ratio of horizontal to resultant force

Table 3 Summary of the studies H-FVP main topics of investigation and primary outcomes

Study	H-FVP topics	Main Outcome
Baena-Raya et al. [9] (2021)	Association between H-FVP variables and COD	Pmax showed a strong association with change-of-direction performance, suggesting H-FVP relevance for multidirectional tasks.
Ben Hassen et al. [17] (2023)	H-FVP among players' position	H-FVP outputs differed by playing position, with forwards showing the highest V0 and Pmax, and goalkeepers the lowest.
Fernández-Galván et al. [18] (2022)	Maturation impact on H-FVP	Acceleration-related variables (F0, RF) improved mainly from pre- to mid-PHV, while top-speed metrics (V0, DRF) progressed more from mid- to post-PHV, reflecting maturation-related performance shifts.
Haugen et al. [19] (2020)	H-FVP differences by standard, position, age and sex	H-FVP parameters varied by playing standard, position, age, and sex: higher-level players, forwards, and males showed superior metrics, while V0, Pmax, and RF were lowest in older males and younger females.
Hermosilla-Palma et al. [20] (2022)	H-FVP changes during repeated sprints	Repeated sprint fatigue reduced high-speed force output (V0, Pmax, DRF), while early-acceleration variables (F0, RF) remained stable.
Ince et al. [21] (2025)	Association of limb asymmetry, sprint kinematics and H-FVP	Asymmetry in H180^{0}.s^{-1} turns was moderately associated with lower F0 and Pmax, and higher RF and DRF, indicating its influence on sprint mechanics.
Jiménez-Reyes et al. [22] (2019)	H-FVP in soccer vs. futsal; sex and level differences	H-FVP parameters were higher in soccer players, males, and higher-level athletes, particularly for V0 and Pmax; DRF differences were inconsistent.
Jiménez-Reyes et al. [5] (2022)	Seasonal changes in H-FVP	F0, Pmax, and RF fluctuated across the season, peaking mid-season and declining later, while V0 and DRF remained stable. Findings highlight the need to sustain sprint-specific stimuli to maintain force-oriented metrics.
Marcote-Pequeño et al. [23] (2019)	Association between H-FVP and sprint performance	In elite female players, Pmax strongly predicted sprint performance, while V0 showed moderate transfer between sprint and jump ability.
Mendiguchia et al. [24] (2016)	Association between simple method and sprint mechanics changes in hamstring injury.	Following injury, F0 remained reduced at return to sport, while V0 was unaffected.
Mitrecic et al. [25] (2025)	Association between H-FVP and sprint, slalom, and kick	H-FVP parameters (Pmax, F0, RF, DRF) were strongly associated with sprint phases, especially acceleration and top-speed; however, no link was found with slalom ability.
Robles-Ruiz et al. [26] (2023)	Association between H-FVP parameters and COD	F0, Pmax, and RF were associated with better ZigZag COD performance, while V0 and DRF showed no relationship.
Sánchez-López et al. [8] (2023)	Association between H-FVP parameters and two COD protocols	V0 and F0 were strongly associated with 505 and M505 performance. However, higher F0 correlated with greater COD deficit in youth/amateurs, while higher V0 reduced COD deficit in professionals.
Zhang et al. [27] (2021)	H-FVP differences between aerial and terrestrial runners	Terrestrial runners showed higher F0, Pmax, and RF than aerial runners, indicating a more force-oriented FVP suited to short sprints; V_0 did not differ.

Note: H-FVP - horizontal force-velocity profile; COD - change of direction; F0 - theoretical maximal force; V0 - theoretical maximal velocity; Pmax - maximal power; RF - ratio of horizontal to resultant force; DRF - decrease in the ratio of horizontal to resultant force; PHV - peak height velocity; H180^{0}.s^{-1} - hamstring strength at 180^{0}.s^{-1}

standardised procedures to ensure accurate and practical application.

The utilization of H-FVP in soccer

H-FVP can provide valuable insights for individualised training programs to improve sprint and COD ability in soccer. Specifically, F0 and Pmax have been demonstrated to be strongly associated with COD performance [9, 26]. F0 is particularly relevant for COD without run-up (i.e., from a stationary start), while V0 is more influential in COD with run-up (i.e., involving pre-existing momentum) [8]. Assessing these variables enables coaches to detect mechanical deficits and design targeted interventions. Athletes with force deficits may benefit from horizontal strength-based exercises (e.g., resisted sprints), whereas those with velocity deficits might require maximal sprint drills. Force-dominant exercises (e.g., heavy resisted sprints) can enhance F0, while velocity or power-dominant drills (e.g., assisted or light-resisted sprints) develop Pmax and V0 [9, 19, 25].

Although training interventions were not the primary focus of this review, several included studies reported positive effects of specific training programs on H-FVP parameters. Interventions such as strength training, sprinting, and orientation-specific plyometric exercises demonstrated significant improvements in key metrics like Pmax, RF, RFmax, DRF, and V0 [29, 30]. For example, strength-focused protocols showed greater gains in horizontal power, while horizontal plyometrics outperformed vertical variants in enhancing force application [30]. Additionally, combining strength and sprint training appeared to further optimise outcomes, especially in maturing athletes [18, 31]. These findings highlight the potential of targeted training approaches to improve H-FVP, underscoring the importance of individualized programming and regular monitoring.

Despite limited research on the link between H-FVP and injury risk, initial studies indicate its potential role in preventing injuries. For example, one study found that F0 production at low speed was altered both before and after a return to play following hamstring injury [24], suggesting that monitoring force output during sprinting may inform insights into rehabilitation and readiness for competition. H-FVP variables such as V0, DRF and Pmax are sensitive to accumulated fatigue, and regular monitoring may enable coaches to adjust training loads accordingly to reduce the risk of soft tissue injuries. Nevertheless, while associations exist, current evidence is insufficient to conclude that H-FVP monitoring alone can prevent or minimise injuries. Further longitudinal studies, especially during a soccer season, are needed to establish its predictive value.

Influence of sex, age, and playing role on H-FVP characteristics

Zhang et al. [27] reported that youth players with a 'terrestrial' sprint profile, characterised by higher F0 and Pmax, showed better short-distance sprint performance and were more suited to roles such as defenders and midfielders. Conversely, an 'aerial' profile, marked by higher V0, might be more suited to those who engage in longer sprints. Fernandez-Galvan et al. [18] showed that force-related variables (F0, RF) develop predominantly between pre- to mid-peak height velocity (PHV), while velocity-related components (V0, DRF) improve more from mid- to post-PHV, indicating that training strategies should align with maturational stages. Sex-based differences in H-FVP are also evident. Jiménez-Reyes et al. [22] observed that male players consistently show higher F0, V0 and Pmax than female players, with the most pronounced difference observed in V0. Haugen et al. [19] recommended that female athletes prioritise velocity-based training to compensate for typically lower sprint velocities.

However, only one study in the review investigated exclusively on female players exclusively, with three others including mixed-sex cohorts. Documented sex-related differences, such as lower F0 and Pmax, but comparable force orientation patterns, suggest that applying male-derived thresholds to female athletes is inappropriate [19]. These discrepancies likely reflect physiological factors such as lower lean muscle mass, greater tendon compliance and sex-specific neuromuscular facilitation patterns, which constrain maximal horizontal force production. Additionally, higher-level athletes generally outperform their lower-level peers in F0 and Pmax, likely reflecting training-induced neuromuscular adaptations.

Overall, these findings support the use of the H-FVP as a diagnostic and programming tool tailored to biological sex, playing role and maturational status. Nonetheless, heterogeneity in testing protocols, such as sprint distance, device type and modeling approaches, warrants careful interpretation.

Methodological considerations and H-FVP measurement devices

Most studies in the review employed Samozino's method to assess H-FVP, using biomechanical models derived from sprint velocity-time data, captured by radar, laser or mobile applications. Commonly used tools include the Stalker ATS II radar and video-based apps such as MySprint. Incorporating split times, anthropometric data and spatiotemporal variables enhances the accuracy of H-FVP analysis.

Several comparative studies have explored the validity and reliability of different technologies for assessing H-FVP. Feser et al. [32] reported minimal bias ($<6.32\%$)

between the 1080 Sprint and radar systems, but noted random error > 7% and modelling issues in 25% of athletes due to early rapid velocity increases. Clavel et al. [6] found moderate to nearly perfect correlations between GPS (Catapult Vector S7) and radar in elite rugby players, with acceptable error margins and high inter-unit reliability. Vantieghem-Nicolas et al. [28] demonstrated that a 50 Hz GPS device (K-AI Wearable Tech) showed stronger validity than lower-frequency devices, although correlations varied by parameters.

While the 1080 Sprint presents some modelling challenges, advances in GPS technologies, particularly those with higher sampling rates and dual-constellation systems, offer a promising alternative for field-based H-FVP assessment. Nevertheless, many practitioners still use 10 Hz GPS due to compatibility with existing workflows and concerns over data variability at higher frequencies [6]. Therefore, when assessing the H-FVP in applied settings, practitioners should prioritize valid and reliable technologies while ensuring consistency in device selection to allow for longitudinal monitoring. However, even these technologies may present specific limitations that should be considered when interpreting results.

Despite their practicality, these methods are not without limitations. Radar-based assessments may be susceptible to external factors such as surface variability and environmental conditions (e.g., wind resistance), impacting data consistency. Video-based analysis, while practical and accessible, depends on frame rate accuracy and marker placement, introducing potential errors in velocity estimation. Moreover, although spatiotemporal and anthropometric data improve sprint analysis, they may not fully capture individual biomechanical differences, limiting the precision of H-FVP assessments. Addressing these methodological considerations is essential for improving the accuracy and applicability of H-FVP evaluations in soccer.

A recent commentary challenged the utility of sprint FVP, calling it a "dead end" and suggesting it adds little beyond raw split-time data [33]. Notably, 10 of 14 studies included in this review reported split times, limiting replication and comparison. The present review, therefore, recommends that future include detailed reporting of 5, 10, 15 and 20 m splits alongside derived force-velocity parameters.

Limitations

Although this rapid review is the first to synthesise the application of H-FVP in soccer players, some limitations must be considered when interpreting the findings. The included studies used heterogeneous methodologies, differing in measurement devices, sprint distances and modelling approaches, which limits the comparability of results across studies. Furthermore, the majority of research focuses predominantly on male athletes, with limited data available for female players. While the rapid review methodology offers efficiency and has been recommended for timely evidence synthesis, it may have led to the omission of some articles due to time constraints and the narrow focus of inclusion criteria. In particular, the decision to include only studies where H-FVP was a primary outcome may have excluded some data from studies where it was analysed as a secondary measure. However, we believe that these methodological limitations did not substantially affect the main findings of the review, as the core trends and interpretations remained consistent across the selected studies. Finally, the high risk of bias observed in most of the included studies further limits the strength of the conclusion.

Practical applications

Current heterogeneity in devices, modelling procedures and sprint distances limits meta-analytic synthesis. As a step foward, we propose minimal reporting standards: (i) linear sprints over 30–40 m; (ii) at least two trials following a standardised warm-up; (iii) split times at 5-m intervals; (iv) Samozino two-point model with body-mass normalisation; and (v) documentation of surface and wind conditions. Adoption of such standards would improve cross-study comparability.

Conclusion

This rapid review highlights the relevance of horizontal force-velocity profiling (H-FVP) in soccer, particularly its association with sprint and change of direction (COD) performance. Key mechanical parameters, such as F0, V0, and Pmax, show a strong relationship with acceleration and differ according to playing position, competitive level, and biological maturation status. The Samozino method emerged as the most frequently used approach for calculating H-FVP, with radar systems and video-based analysis being the primary measurement technologies. However, considerable variability in sprint test protocols and assessment devices highlights the need for standardised procedures to improve comparability across studies and support broader practical implementation.

Although preliminary evidence suggests a role for H-FVP in injury risk monitoring, especially for hamstring injuries, robust conclusions are limited by the scarcity of more longitudinal studies. The current literature lacks sufficient data on female athletes and often shows methodological inconsistencies, which calls for more inclusive and rigorous future studies. Further investigations are needed to validate the use of H-FVP in injury prevention and return-to-play, as well as to explore sex-specific responses and developmental differences.

Establishing best practices for implementing H-FVP in soccer settings will be crucial for maximizing its utility in performance improvement. Consistent reporting of sprint split-time data, precise documentation of measurement tools and detailed descriptions of testing protocols are essential steps toward improving transparency and advancing the practical value of force-velocity profiling in sport.

Supplementary Information

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Supplementary Material 1

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Author contributions

Conceptualization - A.L.; A.C.P.; T.K.Methodology - A.L.; A.C.P.; L.L.Data curation - A.L.; L.L.Writing-original draf - A.L.; A.C.P.Review and editing - M.M.; K.P.; L.L.; T.K.; A.C.P.

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Data availability

All data generated or analyzed during this study are included in this manuscript or supplementary material.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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