



Article

Differential Associations of the Dynamic Strength Index with Dynamic and Isometric Force Manifestations in Professional Female Soccer Players

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Abstract

Background/Objectives: The Dynamic Strength Index (DSI) has been proposed as an indicator of the ability to dynamically express maximum available strength; however, its practical significance remains unclear. This study examined the associations of the DSI with dynamic and isometric strength measures, as well as sprint performance, in female professional soccer players. **Methods:** Eighteen female professional soccer players were assessed during pre-season. The DSI was calculated from peak force obtained in the countermovement jump (CMJ) and the isometric mid-thigh pull (IMTP). Spearman's correlations were analysed alongside bootstrap confidence intervals, false discovery rate (FDR) adjustment, dependent correlation comparisons, and partial correlations controlling for body mass. **Results:** The DSI showed moderate **unadjusted** associations with relative CMJ peak force ($\rho = 0.59$) and relative CMJ peak yank ($\rho = 0.56$). However, no associations remained statistically significant after FDR correction. Despite this, the overall pattern of effect sizes and confidence intervals suggested a tendency towards stronger associations with dynamic rather than isometric variables. No meaningful associations were observed with IMTP-derived variables or sprint performance. **Conclusions:** In this exploratory sample, the DSI showed a tendency towards stronger associations with relative dynamic force variables than with isometric measures. However, given the lack of statistical significance after correction for multiple comparisons, these findings should be interpreted cautiously. The DSI may be better considered as a complementary metric within a broader neuromuscular assessment framework rather than as a standalone indicator.



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1. Introduction

Muscle strength is a key determinant of athletic performance across a wide range of sports [1,2]. However, its expression is multidimensional, encompassing distinct manifestations such as maximum isometric strength, dynamic strength, and reactive strength, which may contribute differently to performance depending on task demands [2–5]. In activities such as jumping and sprint acceleration, performance depends not only on the magnitude of force but also on the ability to generate and apply it rapidly [1,6].

In applied settings, the countermovement jump (CMJ) and the isometric mid-thigh pull (IMTP) are widely used to assess dynamic and isometric strength capabilities, respectively [7,8]. Despite their widespread use, associations between variables derived from these tests are typically low to moderate, suggesting that they capture partially independent dimensions of neuromuscular function [7,9]. This highlights that the capacity to produce high levels of force does not necessarily translate into its effective expression during dynamic tasks.

To integrate these two aspects, the Dynamic Strength Index (DSI) has been proposed as the ratio between peak force obtained in a ballistic task (e.g., CMJ) and peak force achieved in an isometric task (e.g., IMTP) [9–11]. Conceptually, the DSI has been interpreted as an indicator of the extent to which an individual can express their maximum available force during dynamic movements, and has been used in practice to inform training decisions [12–14].

However, the interpretation of the DSI presents important limitations. The peak force obtained during the CMJ may be influenced by execution strategy and technical factors, while the index itself is inherently dependent on its isometric denominator [10,15]. Consequently, changes in DSI may occur without meaningful changes in dynamic performance. In addition, previous research has reported inconsistent relationships between DSI and performance outcomes across different populations [11,16], raising questions about its validity as an integrative indicator of neuromuscular function.

Despite its growing use, it remains unclear whether the DSI primarily reflects dynamic strength, isometric strength, or a combination of both. Furthermore, its relationship with performance outcomes such as sprinting remains inconsistent, particularly in specific populations such as female professional soccer players [9,17,18]. Therefore, the aim of this study was to examine the associations between the DSI and dynamic and isometric force measures, and to determine its relationship with sprint performance in professional female soccer players.

2. Materials and Methods

2.1. Study Design

The study adopted a quantitative approach with a cross-sectional observational design of correlational scope. The sample was selected using a non-probabilistic convenience sampling method.

2.2. Participants

The sample consisted of 18 professional female soccer players belonging to a team competing in the first division of the Chilean professional league (age = 24.4 ± 5.9 years; body mass = 60.2 ± 5.9 kg; height = 160 ± 5.7 cm). The inclusion criteria were: (i) being

a member of the club's senior team; and (ii) actively competing in the first division of professional women's soccer in Chile. The exclusion criteria were as follows: (i) presence of pain or injury in the lower limbs prior to testing; (ii) failure to complete all assessments; and (iii) having performed strength training on the day prior to testing. All participants provided informed consent by signing a consent form authorizing the use of their data for scientific purposes. The study protocol was conducted in accordance with the Declaration of Helsinki for research involving human participants.

2.3. Procedures

Strength assessments were conducted using the countermovement jump (CMJ) and the isometric mid-thigh pull (IMTP). Testing sessions took place during the second and third weeks of the pre-season at the training facilities of Club Universidad de Chile, located in Santiago, Chile. All evaluations were carried out by three researchers in collaboration with the team's strength and conditioning coach.

The order of assessments was as follows: anthropometric measurements, CMJ, and IMTP. A standardized warm-up protocol was implemented, consisting of 5 min of cycling on a stationary ergometer at moderate intensity, followed by one set of dynamic mobility exercises. Subsequently, participants performed two sets of unloaded strength exercises, including 6 squats, 4 lunges, and 5 bilateral landing technique drills, with 1 min of rest between exercises. After the general warm-up, a specific warm-up was performed, including movements related to each test.

2.4. Anthropometric Measurements

Participants' height was measured using a wall-mounted stadiometer (SECA, model 206, Hamburg, Germany; accuracy: 0.1 cm). Body mass was assessed using dual force platforms (PASPORT PS-2141, CA, USA). During measurement, participants were instructed to stand still with their hands on their hips and gaze directed forward for 2 s. Body mass (kg) was calculated by averaging the recorded force signal and dividing it by gravitational acceleration ($9.806 \text{ m}\cdot\text{s}^{-2}$).

2.5. Countermovement Jump (CMJ)

Following the general warm-up, participants completed a specific warm-up consisting of five submaximal jumps. Subsequently, three maximal CMJ trials were performed, with 2 min of rest between attempts. The depth of the countermovement was self-selected according to each participant's comfort. Participants were instructed to "jump as fast and as high as possible" [19]. Data were recorded using Pasco Capstone software (version 1.13.4, USA), exported to a Microsoft Excel spreadsheet (version 16, Microsoft, USA), and subsequently processed in MATLAB (version 9.6, USA). The variables analysed included jump height, calculated from take-off velocity [20], as well as peak force, expressed in absolute terms and relative to body mass (PF and CMJ Peak Force, respectively).

2.6. Isometric Mid-Thigh Pull (IMTP)

Two force platforms (PASPORT PS-2141, CA, USA), previously validated, were used to assess isometric strength. The execution of the test followed the methodological guidelines described by Comfort et al. (2019) [21]. The specific warm-up consisted of three submaximal IMTP attempts at 50%, 75%, and 90% of perceived effort, with 1 min of rest between attempts. Following this, participants performed three maximal trials. Each trial began with the standardized instruction: "push against the ground as fast and as hard as possible." Each trial lasted a total of eight seconds, including an initial three-second preparatory phase followed by five seconds of maximal effort. A rest period of two minutes was provided between trials.

Data were recorded using Pasco Capstone software (version 1.13.4, USA). Force-time data were sampled at 1000 Hz without additional filtering. The onset of force production was defined as the point at which force exceeded five standard deviations above the baseline force signal. Rate of force development (RFD) was calculated using the classical formula: $(\text{final force} - \text{initial force}) / (\text{final time} - \text{initial time})$. Exported to Microsoft Excel (version 16, Microsoft, USA), and subsequently processed in MATLAB (version 9.6, USA). The variables analysed included peak force in both absolute terms and relative to body mass (PF and Relative CMJ Peak Force, respectively).

2.7. Dynamic Strength Index (DSI)

The DSI was calculated as the ratio between peak force obtained during the CMJ and peak force obtained during the IMTP. Both variables were derived from the vertical ground reaction force signal and expressed in absolute terms (N), without normalization to body mass. Peak force was defined as the maximum force value recorded during each respective test.

2.8. Sprint Performance

Sprint performance was assessed over 10 m and 30 m using a photocell timing system (Microgate Witty, Microgate, Bolzano, Italy). The timing gates were positioned at the start line, 10 m, and 30 m, and mounted on tripods at a height of 1 m, following previous recommendations [22]. Participants performed two maximal sprint trials for each distance on an outdoor soccer surface while wearing their regular soccer footwear. The starting position was standardized, with the front foot placed 1 m behind the first timing gate. Participants were instructed to sprint maximally from the start through the finish line. A full recovery period (>3 min) was provided between trials, and the fastest time for each distance was retained for analysis. Missing sprint data were due to scheduling constraints and technical issues, resulting in reduced sample sizes (10 m: $n = 16$; 30 m: $n = 15$).

2.9. Statistical Analysis

Statistical analyses were performed using R software (version 2026.01.0+392; R Foundation for Statistical Computing, Vienna, Austria). Descriptive statistics were calculated for all variables using mean $\pm$ standard deviation or median and interquartile range, depending on data distribution. The presence of outliers was assessed through visual inspection of boxplots and interquartile range criteria. Normality of continuous variables was evaluated using the Shapiro–Wilk test.

Given the non-normal distribution of the Dynamic Strength Index (DSI) and the relatively small sample size ($n = 18$), associations between variables were analysed using Spearman's rank correlation coefficient (ρ). Correlations were calculated between the DSI and variables derived from the countermovement jump (CMJ), including jump height, peak force (absolute and relative), and peak yank (absolute and relative), defined as the first derivative of the force–time curve (i.e., the rate of change in force), as well as variables obtained from the isometric mid-thigh pull (IMTP), including peak force (absolute and relative), rate of force development at 50, 100, and 200 ms, and peak yank (i.e., the rate of change in force). Additionally, associations between the DSI and linear sprint performance over 10 and 30 m were examined.

Given the exploratory nature of the study, primary emphasis was placed on the magnitude of associations and their corresponding confidence intervals, rather than solely on statistical significance. Unadjusted p -values are reported for completeness; however, false discovery rate (FDR)-adjusted p -values using the Benjamini–Hochberg procedure were considered for the interpretation of statistical significance.

To assess the stability of the observed associations, 95% confidence intervals were estimated using bootstrap resampling (5000 iterations) with the percentile method. The magnitude of the correlations was interpreted based on the absolute value of the coefficient using conventional thresholds.

Considering that the DSI represents a ratio between dynamic and isometric peak force, the potential influence of mathematical coupling was acknowledged. To address this limitation, analyses were complemented by examining relationships between variables expressed relative to body mass independently. In addition, comparisons of dependent correlations were conducted using Steiger's method to determine whether the strength of association between the DSI and dynamic variables differed from its association with isometric variables. The use of this approach is justified as it allows comparison of correlations sharing a common variable within the same sample.

To further explore the influence of body size, partial Spearman correlations were calculated while controlling for body mass, implemented through prior rank transformation of the variables. This approach was included despite the use of relative variables, given the potential influence of scaling on ratio-based indices such as the DSI.

No a priori sample size calculation was performed. However, sensitivity considerations indicate that the present sample size provides sensitivity primarily for detecting moderate-to-large correlations ($\rho \approx 0.60$). Statistical significance was set at $\alpha = 0.05$.

3. Results

Descriptive statistics for all variables are presented in Table 1. The DSI showed a mean of 0.95 ± 0.08 and a positively skewed distribution (skew = 1.46), confirming its non-normal distribution. The dynamic and isometric variables showed approximately symmetrical distributions. The number of observations varied in the sprint-related analyses due to missing data (10 m: $n = 16$; 30 m: $n = 15$).

Table 1. Descriptive characteristics of participants and neuromuscular variables.

Variable	<i>n</i>	Mean	SD	Median	IQR	Min	Max	Skew	Kurtosis
Age (years)	18	24.44	5.87	22	10.5	17	33	0.29	−1.67
Body mass (kg)	18	60.22	5.91	60.5	8	46	71	−0.33	−0.09
Height (cm)	18	160.89	5.75	159.5	9.25	152	171	0.22	−1.28
DSI	18	0.95	0.08	0.95	0.08	0.88	1.19	1.46	2
CMJ PF (N)	18	1450.93	199.19	1423.33	241.17	1165.33	1860	0.6	−0.68
Relative CMJ PF ($\text{N} \cdot \text{kg}^{-1}$)	18	24.09	2.23	23.33	2.5	21.33	30	1.06	0.45
CMJ Peak Yank ($\text{N} \cdot \text{s}^{-1}$)	18	10,528.09	4243.86	9806.67	2763.08	6054	24,627	1.99	4.05
Relative CMJ Peak Yank ($\text{N} \cdot \text{s}^{-1} \cdot \text{kg}^{-1}$)	18	174.49	65.9	158.67	47.72	108.11	397.21	2.03	4.46
IMTP Peak Force (N)	18	1525.79	193.63	1562.83	229.5	1198.67	1880.33	−0.16	−1.04
Relative IMTP PF ($\text{N} \cdot \text{kg}^{-1}$)	18	25.31	1.65	25.07	2.02	22.26	28.49	0.14	−0.7
IMTP RFD 50 ms ($\text{N} \cdot \text{s}^{-1}$)	18	3210.19	1808.76	2931	1376.33	688.5	7538	1	0.12
IMTP RFD 100 ms ($\text{N} \cdot \text{s}^{-1}$)	18	3368.92	1369.64	3132.5	1134.75	1588.67	6829.67	1.01	0.28
IMTP RFD 200 ms ($\text{N} \cdot \text{s}^{-1}$)	18	6146.35	1366.99	5662.67	1880.17	4499.67	8988.33	0.52	−1.03
IMTP Peak Yank ($\text{N} \cdot \text{s}^{-1}$)	18	5417.19	1679.56	4761.08	1837.96	3486	9231.33	0.72	−0.61
Sprint 10 m (s)	16	1.91	0.08	1.92	0.12	1.78	2.05	0.02	−1.43
Sprint 30 m (s)	15	4.72	0.26	4.71	0.33	4.19	5.32	0.2	0.06

Abbreviations: CMJ, countermovement jump; DSI, Dynamic Strength Index; IQR, interquartile range; IMTP, isometric mid-thigh pull; PF, peak force; RFD, rate of force development; SD, standard deviation; N, Newtons; kg, kilograms; cm, centimetres; ms, milliseconds; s, seconds.

The full set of correlation coefficients, confidence intervals, and *p*-values is presented in Table 2.

Table 2. Correlations between the Dynamic Strength Index and CMJ, IMTP, and sprint variables.

Variable	<i>n</i>	Spearman's ρ	95% CI	<i>p</i> -Value	FDR-Adjusted <i>p</i> -Value	Partial ρ	Partial <i>p</i> -Value
Relative CMJ Peak Force ($\text{N}\cdot\text{kg}^{-1}$)	18	0.59	[0.189, 0.838]	0.01	0.1026	0.631	0.0066
Relative CMJ Peak Yank ($\text{N}\cdot\text{s}^{-1}\cdot\text{kg}^{-1}$)	18	0.564	[0.062, 0.881]	0.0147	0.1026	0.609	0.0094
CMJ Peak Yank ($\text{N}\cdot\text{s}^{-1}$)	18	0.42	[−0.092, 0.779]	0.0827	0.2894	0.641	0.0056
IMTP RFD 100 ms ($\text{N}\cdot\text{s}^{-1}$)	18	−0.42	[−0.839, 0.118]	0.0827	0.2894	−0.396	0.1153
CMJ Jump Height (cm)	18	0.358	[−0.144, 0.72]	0.1451	0.3431	0.406	0.1061
IMTP Peak Force (N)	18	−0.356	[−0.696, 0.137]	0.147	0.3431	−0.201	0.4393
IMTP RFD 200 ms ($\text{N}\cdot\text{s}^{-1}$)	18	−0.311	[−0.759, 0.258]	0.2096	0.4193	−0.206	0.4268
IMTP RFD 50 ms ($\text{N}\cdot\text{s}^{-1}$)	18	−0.273	[−0.748, 0.291]	0.2722	0.4718	−0.283	0.2708
IMTP Peak Yank ($\text{N}\cdot\text{s}^{-1}$)	18	−0.257	[−0.681, 0.249]	0.3033	0.4718	−0.173	0.507
Relative IMTP Peak Force ($\text{N}\cdot\text{kg}^{-1}$)	18	−0.226	[−0.663, 0.315]	0.3672	0.514	−0.161	0.5377
Sprint 10 m (s)	16	−0.167	[−0.626, 0.32]	0.5376	0.6819	−0.194	0.4893
CMJ Peak Force (N)	18	0.128	[−0.379, 0.587]	0.6127	0.6819	0.568	0.0174
Relative IMTP RFD 200 ms ($\text{N}\cdot\text{s}^{-1}\cdot\text{kg}^{-1}$)	18	−0.121	[−0.587, 0.405]	0.6332	0.6819	−0.14	0.591
Sprint 30 m (s)	15	0.032	[−0.483, 0.498]	0.9093	0.9093	0.002	0.9957

Abbreviations: CI, confidence interval; CMJ, countermovement jump; FDR, false discovery rate; IMTP, isometric mid-thigh pull; RFD, rate of force development; ρ , Spearman's correlation coefficient.

To further assess the stability of these associations, bootstrap resampling (5000 iterations) was performed. The resulting 95% confidence intervals did not include zero for relative CMJ peak force (95% CI [0.19, 0.84]) and relative CMJ peak yank (95% CI [0.06, 0.89]), suggesting a consistent tendency towards positive associations despite the lack of statistical significance after FDR correction (Figure 1).

Bootstrap 95% Confidence Intervals for Key Associations

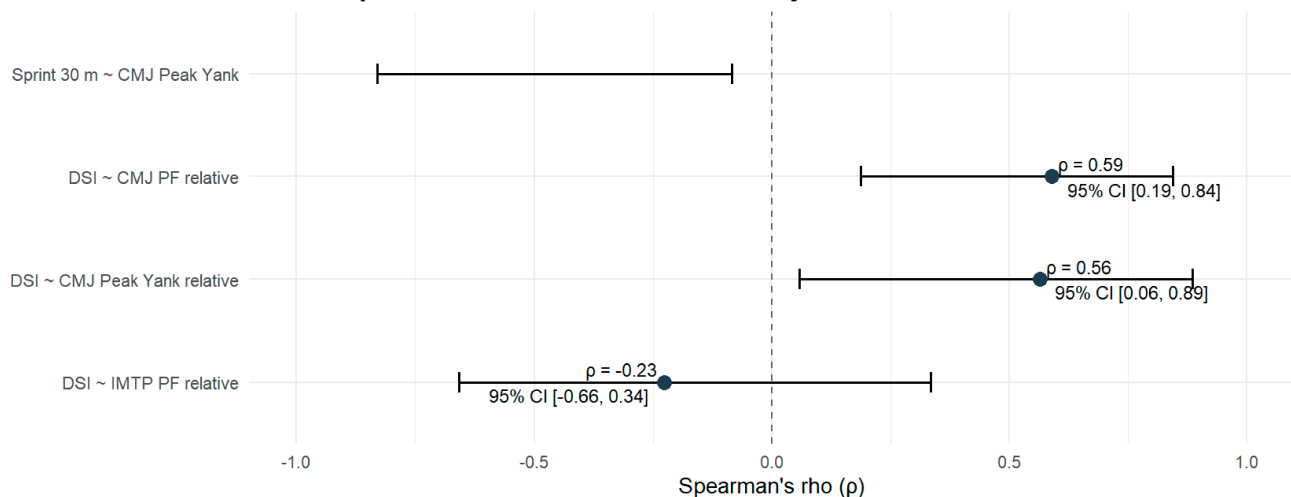


Figure 1. Bootstrapped 95% confidence intervals for key associations between the Dynamic Strength Index (DSI), neuromuscular variables, and sprint performance. Points represent Spearman's correlation coefficients (ρ), and horizontal bars indicate 95% confidence intervals (5000 bootstrap resamples). The vertical dashed line represents zero (no association). DSI showed moderate unadjusted positive associations with relative CMJ peak force and peak yank, whereas associations with IMTP variables were small and uncertain. The CMJ peak yank–30 m sprint association is shown for exploratory purposes.

In the primary analysis, the DSI showed moderate unadjusted positive associations with relative CMJ peak force ($\rho = 0.59$, $p = 0.010$) and relative CMJ peak yank ($\rho = 0.56$,

$p = 0.015$) (Figure 2). However, none of these associations remained statistically significant after false discovery rate (FDR) correction ($p_{\text{FDR}} = 0.1026$ for both variables).

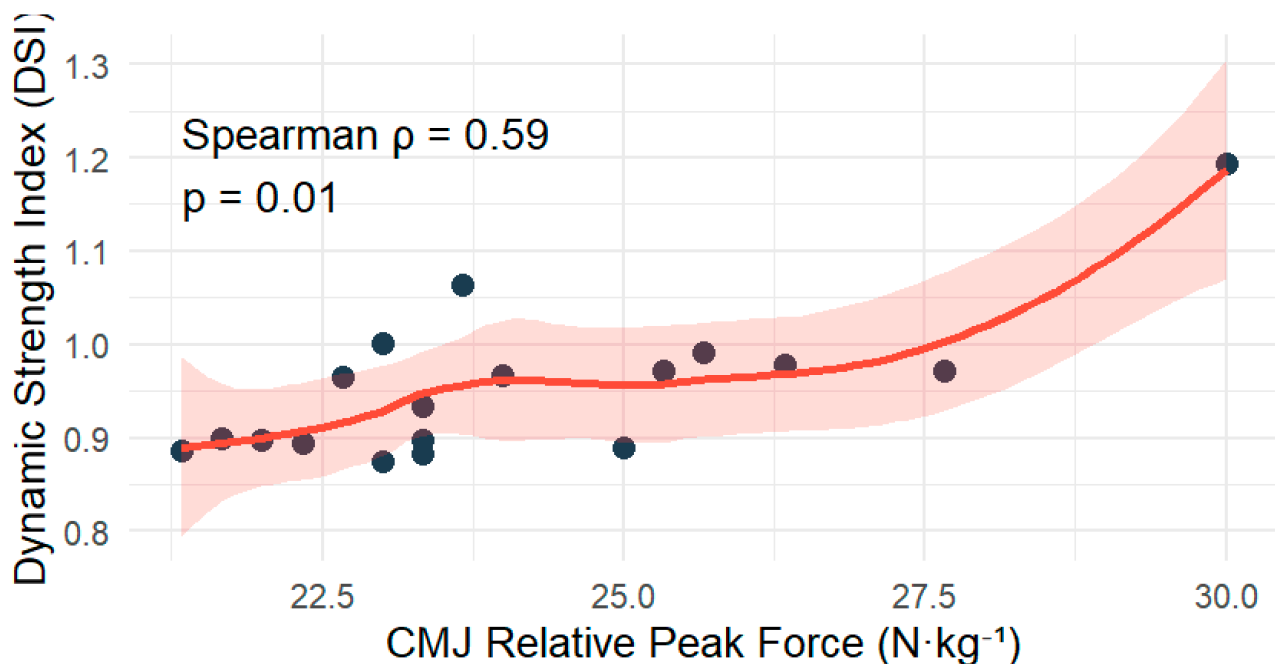


Figure 2. Association between the Dynamic Strength Index (DSI) and relative peak force derived from the countermovement jump (CMJ PF_r). Points represent individual participants ($n = 18$). A moderate positive association was observed (Spearman's $\rho = 0.59$, unadjusted $p = 0.010$). However, this association did not remain statistically significant after false discovery rate (FDR) correction. The solid red line represents a locally estimated scatterplot smoothing (LOESS) curve, and the shaded area indicates the 95% confidence interval.

In contrast, the DSI showed no meaningful associations with isometric variables derived from the IMTP. Correlations with absolute peak force ($\rho = -0.36$, $p = 0.147$) and relative peak force ($\rho = -0.23$, $p = 0.367$; Figure 3) were small to moderate but uncertain, with wide confidence intervals including zero. Similarly, no consistent associations were observed for rate of force development at 50 ms ($\rho = -0.27$), 100 ms ($\rho = -0.42$), or 200 ms ($\rho = -0.31$), nor for peak yank ($\rho = -0.26$), all of which presented confidence intervals overlapping zero. None of these associations remained statistically significant after FDR correction. These findings indicate no clear or consistent association between the DSI and isometric force expression.

After applying FDR adjustment, no associations remained statistically significant, reinforcing the need for cautious interpretation of the observed relationships.

Comparisons of dependent correlations using Steiger's test indicated that the association between the DSI and relative CMJ peak force was stronger in magnitude than its association with relative IMTP peak force ($z = 3.85$, $p = 0.0001$). This pattern remained consistent after sensitivity analysis excluding the highest DSI value, where the association with relative CMJ peak force remained moderate ($\rho = 0.51$, $p = 0.035$), while the association with relative IMTP peak force remained small and non-significant ($\rho = -0.27$, $p = 0.294$). The difference between these correlations remained greater in magnitude ($z = 3.63$, $p = 0.0003$), suggesting that this pattern was not driven by outliers.

Partial correlations controlling for body mass showed a tendency towards stronger associations between the DSI and relative dynamic variables. Specifically, moderate unadjusted partial correlations were observed for relative CMJ peak force ($\rho = 0.63$, $p = 0.0066$) and relative CMJ peak yank ($\rho = 0.61$, $p = 0.0094$). In contrast, the association between the

DSI and relative IMTP peak force remained small and non-significant ($\rho = -0.16$, $p = 0.538$), suggesting that the observed pattern was not explained by body size.

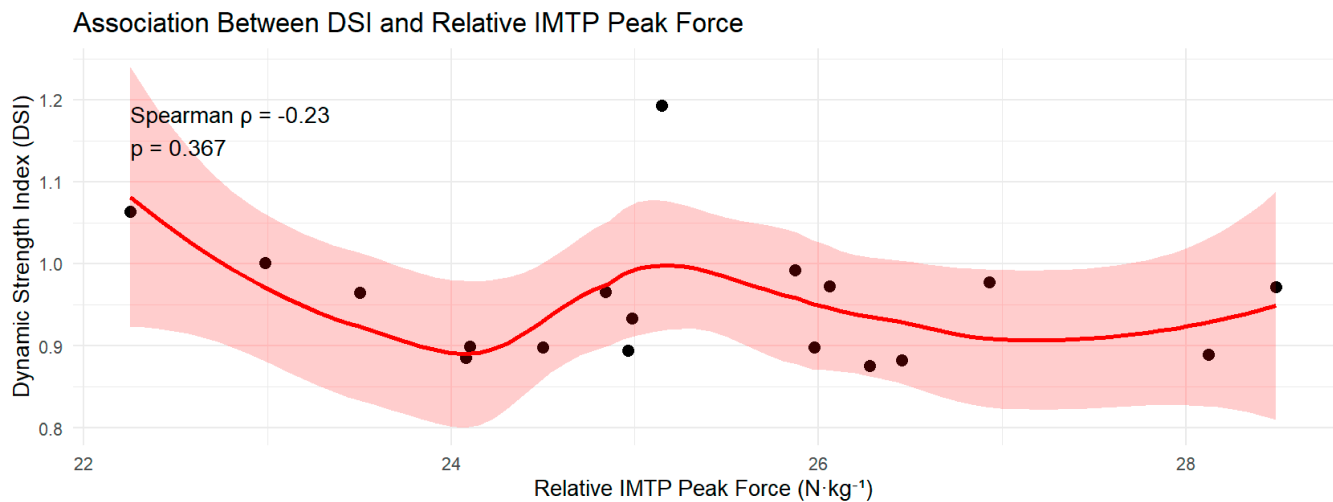


Figure 3. Association between the Dynamic Strength Index (DSI) and relative isometric mid-thigh pull (IMTP) peak force ($\text{N}\cdot\text{kg}^{-1}$). Points represent individual participants ($n = 18$). A small and non-significant association was observed (Spearman's $\rho = -0.23$), and the p -value displayed in the figure corresponds to the unadjusted analysis. This association did not remain statistically significant after false discovery rate (FDR) correction. The red line represents a locally estimated smoothing curve (LOESS) and is presented for visualization purposes only.

Regarding sprint performance, the DSI showed no meaningful associations with either 10 m ($\rho = -0.17$, $p = 0.538$) or 30 m sprint time ($\rho = 0.03$, $p = 0.909$). In exploratory analyses, CMJ peak yank showed a moderate negative association with 30 m sprint time ($\rho = -0.55$, $p = 0.035$), suggesting that higher values may be associated with faster sprint performance. However, this finding should be interpreted with caution given the limited sample size and the exploratory nature of the analysis.

4. Discussion

The main finding of this study was that the Dynamic Strength Index (DSI) showed stronger unadjusted associations with relative dynamic variables derived from the counter-movement jump (CMJ), in particular relative peak force and relative peak yank, whereas no consistent associations were observed with the isometric measures obtained via the isometric mid-thigh pull. However, it is important to note that none of these associations remained statistically significant after FDR correction; therefore, the results should be interpreted with caution. These findings should be interpreted with particular caution given the limited sample size, which reduces statistical power and increases the likelihood of type II error.

This pattern of results suggests that in female professional soccer players, the DSI may tend to be more closely aligned with the expression of force in dynamic tasks than with maximum isometric force. However, these findings do not allow for definitive conclusions regarding the physiological meaning of the index, particularly given the exploratory nature of the study, the relatively small sample size, and the limited statistical power. In addition, these results highlight the potential limitation of extrapolating laboratory-based neuromuscular assessments to sport-specific performance outcomes.

From an applied perspective, these results indicate that the DSI should not be interpreted in isolation nor assumed to represent a balanced reflection of the athlete's overall neuromuscular profile. Rather, it may be influenced by how force is expressed during spe-

cific dynamic tasks such as the CMJ. It is important to emphasise that potential mechanisms such as intermuscular coordination, activation speed, or stretch-shortening cycle utilisation were not directly assessed in the present study and therefore should be considered as possible explanations rather than confirmed interpretations.

A relevant aspect of this study was that the observed associations were concentrated in variables expressed relative to body mass and tended to increase when controlling for body size. This pattern is consistent with previous findings suggesting that the DSI may be more closely related to dynamic force expression, particularly when variables are expressed relative to body mass [23–26]. In this context, normalisation to body mass may be relevant, as performance in tasks such as jumping, acceleration, or change of direction depends on the ability to effectively mobilise body mass [27–29]. In addition, previous evidence in female athletes suggests that relationships between neuromuscular variables are often task-specific and not entirely redundant [30,31]. However, these findings should be interpreted cautiously, as the use of ratio-based variables and the interaction between DSI components may introduce statistical and biomechanical artefacts that influence observed relationships [30–33]. From an applied perspective, these considerations are relevant for training and performance monitoring in female soccer, where body mass and neuromuscular efficiency play an important role in physical performance [34–37].

The lack of associations between the DSI and IMTP-derived variables may reflect the different mechanical characteristics of the CMJ and IMTP, as well as the inherent limitations of ratio-based indices [38–41]. Importantly, because the DSI is mathematically derived from CMJ peak force, associations between the DSI and CMJ variables may be partly expected due to shared variance, and should therefore be interpreted with caution. Although both tests are valid tools for neuromuscular assessment, they capture partially distinct aspects of force production [42–45]. The CMJ reflects a dynamic and ballistic task, whereas the IMTP assesses force under isometric conditions [46–50]. Consequently, the absence of association does not imply that maximum force is not relevant, but rather that the DSI may not equally reflect dynamic and isometric strength qualities in this sample.

Another finding of this study was the absence of meaningful associations between the DSI and sprint performance. This suggests that the DSI, when considered in isolation, may have limited utility for explaining sprint performance in female professional soccer players [51–60]. Given the multifactorial nature of sprinting, which involves not only force magnitude but also direction, timing, stiffness, and technical factors [61–63], it is not surprising that a single index does not capture this complexity [64–66].

In exploratory analyses, CMJ peak yank showed a moderate association with 30 m sprint performance. However, this result should be interpreted with caution due to the limited sample size and the absence of correction for multiple comparisons. While this finding may be of interest, it should be considered preliminary and requires confirmation in larger samples [67–70].

From an applied perspective, the results of this study suggest that the DSI should be interpreted within a broader neuromuscular assessment framework rather than used as a standalone metric. Although no associations remained statistically significant after FDR correction, the overall pattern of effect sizes and confidence intervals suggests a tendency towards stronger associations with dynamic rather than isometric variables. Therefore, the practical value of the DSI may lie in complementing the interpretation of an athlete's neuromuscular profile, rather than in identifying specific “deficits” in isolation.

5. Conclusions

The results of this study suggest that, in this small exploratory sample of female professional soccer players, the Dynamic Strength Index (DSI) showed stronger unadjusted

associations with relative variables derived from the countermovement jump (CMJ) than with variables obtained from the isometric mid-thigh pull (IMTP). However, it is important to note that none of these associations remained statistically significant after FDR correction, and therefore these findings should be interpreted with caution.

In addition, the absence of meaningful associations between the DSI and 10 and 30 m sprint performance suggests that this index, when considered in isolation, may have limited utility for explaining speed performance in this population.

Taken together, these findings indicate that the DSI may be better interpreted as a complementary metric within a broader neuromuscular assessment framework, rather than as a standalone indicator for guiding training decisions.

5.1. Limitations

This study is limited by the relatively small sample size, the absence of an a priori sample-size calculation, and the use of a single-club convenience sample, which restrict generalisability. The cross-sectional design precludes causal inferences and does not allow assessment of the DSI's responsiveness to training. In addition, incomplete sprint data may have influenced the analysis of performance outcomes.

No reliability statistics were reported, and the fixed testing order may have introduced bias. Furthermore, relevant factors such as menstrual-cycle phase, playing position, training history, fatigue status, and recent training load were not controlled.

None of the observed associations remained statistically significant after FDR correction, reinforcing the need for cautious interpretation. Finally, the ratio-based nature of the DSI represents a key interpretative limitation due to its dependence on its components and potential mathematical coupling. Additionally, the laboratory-based nature of the assessments may limit the ecological validity of the findings in relation to sport-specific performance demands.

5.2. Recommendations for Future Research

Future studies should include larger samples and preregistered hypotheses to improve statistical robustness and transparency. Repeated testing protocols are needed to establish the reliability of the DSI and to determine its smallest worthwhile change. In addition, longitudinal and intervention-based designs are required to assess the responsiveness of the DSI to training.

Finally, future research should incorporate sport-specific performance outcomes, including acceleration, change of direction, repeated sprint ability, and fatigue responses, to better understand the practical relevance of the DSI in applied settings.

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