applied sciences

MDPI

Article

Associations Between Dynamic Strength Index and Jumping, Sprinting and Change of Direction Performance in Highly Trained Basketball Players

Jernej Pleša [1,2], Filip Ujaković [2,3], Chris Bishop [4], Nejc Šarabon [1,5] and Žiga Kozinc [1,*]

[1] Faculty of Health Sciences, University of Primorska, Polje 42, SI-6310 Izola, Slovenia; nejc.sarabon@fvz.upr.si (N.Š.)
[2] Basketball Club Cedevita Olimpija, Vojkova 100, 1000 Ljubljana, Slovenia
[3] Faculty of Kinesiology, University of Zagreb, Horvaćanski Zavoj 15, 10000 Zagreb, Croatia
[4] Faculty of Science and Technology, London Sport Institute, Middlesex University, London NW4 1RL, UK; c.bishop@mdx.ac.uk
[5] Ludwig Boltzmann Institute for Rehabilitation Research, Neugebäudeplatz 1, 3100 St. Pölten, Austria
* Correspondence: ziga.kozinc@fvz.upr.si

Abstract: The aim of this study was to investigate associations and differences between dynamic strength index (DSI) and multi-directional jumping, linear and curvilinear sprinting, and change of direction (CoD). Highly trained basketball players (n = 44) performed a 20 m linear sprint, 20 m 3-point line (curvilinear) sprint, countermovement jump (CMJ), drop jump (DJ), bilateral horizontal jump, unilateral horizontal jump, lateral jump, basketball-specific lateral jump and isometric mid-thigh pull (IMTP). The results showed weak to moderate associations between IMTP performance and horizontal jump, lateral jump and curvilinear sprint ($r = -0.33$–0.41; $p < 0.05$). No correlations were found between CMJ peak force and performance variables, while weak correlations were observed between DSI and unilateral horizontal jump ($r = -0.36$; $p < 0.05$), lateral jumps, linear sprint and CoD deficit ($r = -0.37$, -0.38; $p < 0.05$), showing that lower magnitude of DSI is associated with better performance in those tests. Additional analysis revealed that the low DSI subgroup had the highest IMTP peak force, while the high DSI subgroup had the highest CMJ peak force. The low DSI group showed better performance in vertical, horizontal and lateral jumps, while no significant differences were observed in DJ and curvilinear sprint performance compared to other groups. The findings indicate that athletes with lower DSI values exhibit superior physical performance, suggesting that a strength-oriented training approach may be beneficial for basketball players. Due to the ballistic nature of basketball, more maximal strength training is required to optimize the DSI ratio in basketball players. Additional studies are needed to determine the precise benchmarks for navigating training based on DSI values.

Keywords: strength; sprint; jump; change of direction; basketball

Academic Editors: Arkady Voloshin and Kang Su Kim

Received: 27 November 2024
Revised: 24 December 2024
Accepted: 3 January 2025
Published: 5 January 2025

Citation: Pleša, J.; Ujaković, F.; Bishop, C.; Šarabon, N.; Kozinc, Ž. Associations Between Dynamic Strength Index and Jumping, Sprinting and Change of Direction Performance in Highly Trained Basketball Players. *Appl. Sci.* **2025**, *15*, 434. https://doi.org/10.3390/app15010434

1. Introduction

Team sports are generally characterized by high-intensity actions such as jumps, sprints and changes of direction (CoD), with basketball exhibiting the highest number of high-intensity accelerations and decelerations among team sports [1]. The literature reports that basketball players perform more than 300 CoD maneuvers, 50 accelerations and 50 jumps during competitive games [2]. Moreover, previous studies have shown distinctions between basketball players of different competitive levels, where players competing at the higher level exhibit superior strength and power capabilities. Furthermore, higher-level players are also able to sustain high-intensity intermittent efforts for longer durations [3] and to perform these activities with greater intensities during competitive matches [4]. Therefore, evaluating sprint, jump and CoD ability is essential in basketball strength and conditioning, offering insights into athletes' strengths and weaknesses to tailor training programs [5]. Considering the significance of strength and power for basketball players [6–8], biomechanical testing provides detailed insights into neuromuscular capacity, enabling training optimization.

A comprehensive evaluation of strength and power capacities may be achieved by assessing an athlete's performance across different loading conditions [9]. The magnitude of the difference in peak force between different conditions can reflect adaptations of the neuromuscular system to the training process. In this regard, the dynamic strength index (DSI) has been a popular topic of investigation in recent years as it has been recognized as a potentially useful tool to optimize training for improving an individual's physical performance [9–12].

The DSI is determined by comparing the peak force generated during ballistic activities, such as vertical jumps, to the force produced in isometric or quasi-isometric tasks, like the isometric mid-thigh pull (IMTP) [13–15]. DSI reflects an athlete's dynamic force production capacity relative to their maximal force capacity. Although some baseline thresholds have been established [11,13], the exact benchmarks that may correspond to the best physical performance are still not known. Previous studies have demonstrated that DSI varies across team sports, with basketball players displaying the highest DSI values among team sports, ranging from 0.71 to 1.12, with an average value of ~0.90 [11,16,17]. Furthermore, when applying the DSI, it is essential to account for the relative contribution of each component because simultaneous improvements in both components would lead to minimal changes in the DSI itself but would likely enhance overall physical performance.

Additionally, when considering which test protocols to utilize in evaluating independent assessments of physical performance, sports demands should be kept in mind. More precisely, sprints, jumps and CoD actions seem to be crucial movements in basketball [18]. Jumping assessments are among the most popular methods to assess neuromuscular function in basketball [19,20], as the ability to produce high amounts of force into the ground to vertically displace the center of mass is an important ability in basketball for movements such as dunks, rebounds and lay-ups. It must be stressed that jump height alone does not always indicate superior athlete performance as the time component may also play a role in the players being in optimal positions to gather competitive advantages (e.g., grab a rebound) [21]. Additionally, when individuals are not in an optimal physical state, they may change movement strategies to achieve comparable outputs but within a longer time window [22]. Thus, monitoring additional metrics beyond jump height alone is recommended for examining jumping performance in basketball players [23,24]. Along with jumping, running speed is also an important characteristic in basketball [25], as top speeds and rates of acceleration can present important advantages in the game [21]. Additionally, basketball involves not only linear movements but also dynamic, multi-directional actions [3,26] and movements in curvilinear trajectories [27]. More precisely, 31% of total sprints performed without the ball and 59% with the ball are curvilinear [28,29]. Therefore, improving curvilinear qualities may be important to optimize basketball performance. Based on that, optimizing basketball performance relies on addressing other critical movement patterns, such as linear and curvilinear sprints, explosive jumps, rapid CoD and multi-directional force production. A comprehensive evaluation of these parameters ensures a well-rounded physical profile, enabling athletes to adapt their training in order to meet the diverse demands of the game.

While DSI-guided training was recently shown to be potentially more effective in enhancing or maintaining the physical performance of highly trained basketball players during the season compared to non-individualized resistance training [11], there is still a gap in the literature regarding the question about its relationship with physical performance. Previous research provides some information on the relationship between DSI and measures of strength and power derived from the component tests of the DSI metric (IMPT and CMJ) [12,30,31]. However, such results must be questioned, as CMJ, IMPT and DSI metrics do not represent truly independent variables. In contrast, assessing the relationship between CMJ, IMPT and DSI with other independent measures of physical performance (e.g., linear or curvilinear and CoD speed) would be more informative to practitioners, as it would help determine whether the DSI and its constituent variables could serve as useful measurements in practice.

To the authors' knowledge, there are only two studies to date that have examined the relationship between DSI and performance during a completely different task [16,32]. A study on surfers reported that upper body DSI (from the push-up task, isometric push up and dynamic push-up on force plates) had no relationship with sport-specific physical performance ($r = -0.57$–(-0.59); $p = 0.10$–0.12), while on the other hand, both isometric and dynamic strength qualities underpinning the DSI were significantly greater in the better-performing group [33]. The second study on basketball players reported weak correlations between the DSI and CoD ability ($r = 0.36$–0.39), which was underpinned by a moderate correlation between isometric squat strength and CoD ability ($r = -0.43$–(-0.54)) [16]. Thus, it is essential to consider the relative impact of each component, namely the force and ballistic components, as a concurrent increase in both would likely yield minimal changes in DSI but would probably positively influence overall performance. To put it all together, the relationships between DSI and independent measures of athletic performance offer an opportunity for further exploration as it can show the direction of how to improve sport-specific performance with general physical training (strength or ballistic training).

Therefore, this study had two objectives: (1) to assess associations between DSI and sprint, jump and CoD performance and (2) to determine the differences between the physical performance of basketball players in different DSI groups (low, medium and high DSI groups).

2. Materials and Methods

2.1. Study Design

This cross-sectional study took place during the pre-season period as part of the regular testing routine. It was conducted during two separate visits (total time of both visits: ~120 min). Measurements were conducted a week before teams officially started pre-season. The visits were separated by at least two days. In the first visit, participants performed sprint tests, while jumps and strength tests were performed in the second visit. Assessments included bilateral CMJ, drop jump (DJ), IMTP, bilateral horizontal jump, unilateral horizontal jump, lateral jump, lateral basketball specific jump, 20 m sprint test, 20 m 3-point line curvilinear sprint test and 505 CoD test. In both visits, participants performed the same warm-up, consisting of 10 min of jogging, dynamic stretching and body-weight strength exercises (squats, all-direction lunges and planks), followed by 2 familiarization repetitions for each test. For familiarization repetitions, the participants were instructed to gradually increase the effort from ~70 to ~90% of perceived maximal effort. On the first visit, the warm-up was followed by a 20 m linear sprint test, a 3-point line curvilinear sprint test and a 505 CoD test. On the second visit, the warm-up was followed by horizontal jumps, lateral jumps, DJs and CMJs, and finished with a strength test. For all tests, strong verbal encouragement was performed for each of the three repetitions performed, and the maximal values were taken for further analyses. There was a sufficient break between the repetitions and different tests. The protocol was conducted in accordance with the latest revision of the Declaration of Helsinki. The experimental procedures were reviewed and approved by the Slovenian Medical Ethics Committee (approval no. 0120-99/2018/5).

2.2. Participants

Forty-four highly trained basketball players (age: 21.0 ± 4.9 years; body height: 195.9 ± 7.5, body mass: 89.2 ± 11.3) were recruited. Only male basketball players were included in the research to prevent possible confound in the analysis. This sample size was sufficient for confirming moderate, high or very high correlations ($r > 0.40$) with 80% statistical power at an alpha level of 0.05 [33]. During the testing week, participants were instructed to avoid long, intensive physical activities to avoid fatigue on the testing day. Participants had >5 years of basketball experience, with all participants competing at national and international club levels. The participants were excluded if they reported any musculoskeletal injuries and pain syndromes within the last six months or any other medical conditions that could be exacerbated with the measurement procedure. Participants were informed about the details of the protocol and were required to sign an informed consent prior to the beginning of the measurements.

2.3. Linear Sprint

The linear sprint assessment was conducted over a 20 m distance [11], employing three sets of timing gates (Brower Timing Systems, Draper, UT, USA). The starting line was placed 0.3 m behind the timing gates to avoid early triggering. Participants started from a standing position and were free to choose their front leg, which was kept constant throughout all repetitions. Timing gates were placed at the starting line and at the 10 m and 20 m distance. Participants were instructed to sprint from the start line at maximum effort, passing through all sets of timing gates. Three trials were conducted, with a 2 min rest period between each. Three repetitions were performed with a rest period of 2 min. The time was recorded with an accuracy of 0.001 s.

2.4. Curvilinear Sprint

The curvilinear sprint was performed around the 3-point line [27], with a total distance of 20 m using the same pairs of timing gates (Brower Timing Systems, Draper, UT, USA). The starting position was the same as for the linear sprint, 0.3 m behind the timing gates. Timing gates were placed at the starting line and on the other side of the 3-point line at 20 m distance. They were instructed to sprint from the start line over the 3-point line without stepping on the line. If a participant stepped on the 3-point line, the repetition was repeated. Three correct repetitions were performed on both the left and right sides, with a rest period of 2 min between each trial. The time was recorded with an accuracy of 0.001 s.

2.5. Change of Direction

The same set of timing gates (Brower Timing Systems, Draper, UT, USA) were used to assess CoD ability. Participants sprinted for 15 m to the (turning) line, stepped over the line with the left or right foot, turned 180° and sprinted back through the timing gates [34]. Timing gates were placed 5 m before the turning line. If a participant stepped on the marked line, the repetition was repeated. Three correct repetitions were performed for each leg in alternating order, with 2 min rest between repetitions. Additionally, the CoD deficit was calculated following the methodology proposed by Nimphius et al. (2016) [34] to yield a more isolated measure of CoD performance. The CoD deficit was derived by subtracting the 10 m sprint time from the 505 test time. Therefore, the CoD deficit is the additional time required for an athlete to complete a CoD task compared to a linear acceleration over the same distance [34].

2.6. Horizontal and Lateral Jumps

Horizontal and lateral jump tasks were performed on a flat surface (sport parquet). Measuring tapes were affixed to the ground, and participants kept their hands on their hips. Bilateral horizontal jump (BHJ) was performed with hand free, while single-leg horizontal jump (SLHJ), single-leg lateral jump (SLLJ) and single-leg basketball specific lateral (SLSLJ) were performed with hand on the hips. Countermovement was allowed for all jumps, and landing was performed on both limbs. The distance was recorded from the starting line to the point where the heel landed upon the completion of the jump. For SLLJ and SLSLJ, the participants placed the medial border of the stance foot behind the starting line, with the other leg facing in the direction of the jump.

2.7. Vertical Jumps

DJs and CMJs were performed on a piezoelectric force plate (Kistler, model 9260AA6, Winterthur, Switzerland). Ground reaction force data were recorded at a sampling rate of 1000 Hz. The signals were automatically processed by the manufacturer's software (MARS, Kistler, Winterthur, Switzerland) by a moving average filter with a 5 ms window. Each task was performed three times, with 1 min break between trials. The hands were placed on the hips at all times. For the DJ, the participants stood on a solid 0.3 m high box. The participants stepped off the box and performed a vertical jump immediately after the landing. They were instructed to achieve maximal jump height whilst minimizing the ground contact time. When performing the DJ, participants maintained an upright posture. Jump height and contact times were also taken for the analysis, and subsequently, the RSI (RSI_{DJ}) was calculated as the ratio between the jump height and the contact time. Ground contact time was defined as the time during which the force signal was >10 N. The piezoelectric force plate was calibrated in accordance with the manufacturer's guidelines to ensure accurate measurement.

When performing CMJ, participants were instructed to perform explosive countermovement to self-selected depth and to jump as high as possible. Participants performed three repetitions with 1-min breaks between the repetitions. Jump height, peak force and time to take off were taken for further analysis, with RSI_{CMJ} calculated by dividing the jump height by the time to take off [35]. Time to take off was determined as the time between the countermovement initiation (defined as the decrease in force signal larger than 3 standard deviations of the baseline signal) and the take-off (defined as the first instant of force < 10 N). Jump height and jump time RSI_{CMJ} were considered indicators of physical performance, while peak force was taken to calculate DSI.

2.8. Isometric Mid-Thigh Pull Testing

The isometric mid-thigh pull (IMTP) assessments [36] were conducted on the same force platform as the vertical jump tests (Type 9229A, Kistler Instruments, Winterthur, Switzerland). The position was determined as the strongest position to pull the bar chosen by players, with knees at ~40° [10]. Participants had to exert a maximal force against a bar that was so firmly connected to the ground that it could only be lifted to a pre-determined height. After two warm-up repetitions at ~50% and ~75% of maximal effort, three repetitions with maximal exertion were performed with a 2 min rest between repetitions. The peak force was taken as the largest mean force in 1 s intervals. Subsequently, DSI variables were calculated by dividing the peak force obtained in CMJ by a peak force obtained during IMTP.

2.9. Statistical Analysis

Three general variables (CMJ peak force, IMTP peak force and DSI) and five performance aspects (linear sprint, curvilinear sprint, CoD test, horizontal jumps and vertical jumps) were taken into statistical analysis. The data are presented as means ± standard deviations. The normality of the data distribution for all variables was verified with the Shapiro–Wilk test, which showed normal data distribution. Inter-repetition reliability analysis was performed using a two-way random intraclass correlation coefficient (ICC) with absolute agreement and 95% confidence intervals (CI) and coefficient of variation (CV). ICC was interpreted as follows: >0.9 (excellent), 0.9–0.75 (good), 0.75–0.50 (moderate) and <0.5 (poor) [37]. Absolute reliability was assessed by calculating the coefficient of variation (CV) according to Hopkins (2000) [38] and interpreted as poor (CV > 10%), moderate (CV = 5–10%), or good (CV < 5%). Pearson correlation coefficients were used to examine the associations between DSI and performance variables. The associations were interpreted as follows: 0.0–0.1 (no association), 0.1–0.4 (weak), 0.4–0.6 (moderate), 0.6–0.8 (strong) and >0.8 (very strong) [39]. A one-way ANOVA with a post hoc test was used to determine the differences between high, mid and low DSI groups. Furthermore, post hoc testing was performed with a Bonferroni correction to measure statistical differences between groups (high, mid, low DSI), and Hedges g was used to determine between-group effect sizes. Effect sizes were interpreted as trivial (<0.2), small (0.2–0.5), medium (0.5–0.8) and large (>0.8) [40]. The threshold for statistical significance was set at $\alpha < 0.05$, and all analyses were carried out in SPSS statistical software (version 25.0, CJ278ML, IBM, USA).

3. Results

The descriptive statistics for all variables are presented in Table 1. Good-to-excellent inter-repetition reliability was shown for the sprint for all vertical (ICC = 0.788–0.978; CV = 2.79–6.22), horizontal and lateral jump parameters (ICC = 0.969–0.979; CV = 1.60–2.36). On the other hand, the 505 test showed good to excellent inter-repetition reliability (ICC = 0.831–0.963; CV = 0.96–2.95), while the CoDD showed good inter-repetition reliability (ICC = 0.825–0.857) but poor absolute reliability (CV = 13.08–14.66), highlighting potential variability in the performance or measurement error. Nevertheless, the best repetition from the 10 m sprint and 505 test was used to calculate CoDD, which was taken for further analysis.

Table 1. Results of descriptive statistics and reliability for all outcome measures.

Outcome Variables	Mean ± SD	Range (Min–Max)	ICC	CV
DSI	0.91 ± 0.13	0.60–1.22	0.967 (0.942–0.982)	4.00
IMTP	2486 ± 433	1734–3679	0.989 (0.982–0.994)	2.60
Bilateral horizontal jump	247 ± 17	209–282	0.977 (0.953–0.989)	1.60
Horizontal jump—L	196 ± 15	170–231	0.971 (0.949–0.983)	1.76
Horizontal jump—R	193 ± 14	160–223	0.967 (0.939–0.982)	1.86
Lateral jump—L	179 ± 17	140–219	0.970 (0.941–0.985)	2.24
Lateral jump—R	175 ± 15	138–208	0.969 (0.949–0.982)	2.36
Specific jump—L	183 ± 17	146–214	0.979 (0.965–0.988)	1.68
Specific jump—L	182 ± 17	138–220	0.975 (0.952–0.986)	2.11
Linear sprint 10 m	1.75 ± 0.08	1.61–1.97	0.909 (0.848–0.949)	1.53
Linear sprint 20 m	3.06 ± 0.11	2.86–3.34	0.963 (0.937–0.979)	0.96
3 pt line sprint L	3.28 ± 0.16	2.91–3.68	0.936 (0.877–0.967)	1.65
3 pt line sprint R	3.32 ± 0.17	2.96–3.72	0.933 (0.886–0.962)	1.77
505—L	2.24 ± 0.11	2.02–2.49	0.831 (0.705–0.908)	2.95
505—R	2.23 ± 0.10	2.01–2.39	0.838 (0.716–0.914)	2.55
CoDD—L	0.50 ± 0.11	0.23–0.72	0.825 (0.696–0.906)	14.66
CoDD—R	0.49 ± 0.11	0.26–0.65	0.857 (0.748–0.932)	13.08

Table 1. *Cont.*

Outcome Variables	Mean ± SD	Range (Min–Max)	ICC	CV
CMJ Height	0.39 ± 0.06	0.24–0.54	0.958 (0.928–0.977)	3.84
CMJ Peak force	2238 ± 362	1635–3172	0.978 (0.963–0.988)	2.79
CMJ RSI	0.52 ± 0.10	0.32–0.75	0.830 (0.696–0.910)	6.79
DJ Height	0.34 ± 0.06	0.21–0.51	0.955 (0.922–0.976)	5.65
DJ RSI	1.60 ± 0.35	0.76–2.87	0.934 (0.881–0.966)	6.06
DJ Contact time	0.21 ± 0.03	0.16–0.34	0.788 (0.616–0.889)	6.22

SD—standard deviation; ICC—interclass correlation; CV—coefficient of variation; DSI—dynamic strength index; IMTP—isometric mid-thigh pull; L—left, R—right; 3 pt—three-point line; 505—change of direction test; RSI—reactive strength index; DJ—drop jump.

3.1. Associations Between Dynamic Strength Index and Performance Measures

IMTP peak force showed weak to moderate correlations with a horizontal jump (r = 0.343), all lateral jumps (r = 0.324–0.441) and 3 pt line sprint on the right side (r = −0.325). Positive correlations indicate that better IMPT peak force corresponds with better lateral jumping ability, while negative correlations indicate that higher IMTP peak force corresponds with better sprint performance. On the other hand, no correlations were found between CMJ peak force and performance measures. Regarding DSI, weak correlations were found between DSI and lateral jump with the right leg (r = −0.326), specific lateral jump on the left leg (r = −0.371), 10 m linear sprint (r = −0.355) and CoD deficit on the right side (r = 0.384). Negative correlations indicate that lower DSI values correspond with better performance in lateral jumps and sprints, while the positive correlation between DSI and CoD deficit indicates that higher DSI values mean less efficiency in CoD. Additional analysis was performed to compare associations between performance variables and CMJ peak force, and CMJ height was also performed. The results showed weak to moderate associations between CMJ height and curvilinear sprint (r = −0.388 to −0.428) and moderate to strong associations between CMJ height and all other performance tests (r = −0.500 to 0.723), except with CoD ability. The results are presented in the table below (Table 2).

Table 2. Results of correlations between DSI and its constituent variables and performance measures.

Performance Measures	DSI	ITMP PF	CMJ PF	CMJ Height
Horizontal jump	−0.162	0.343 *	0.204	0.671 **
Horizontal jump L	−0.355 *	0.292	−0.034	0.723 **
Horizontal jump R	−0.211	0.135	−0.055	0.239
Lateral jump L	−0.289	0.324 *	0.059	0.616 **
Lateral jump R	−0.326 *	0.398 **	0.116	0.645 **
Specific jump L	−0.371 *	0.384 *	0.037	0.649 **
Specific jump R	−0.262	0.411 **	0.162	0.595 **
Linear 10 m	−0.355 *	0.119	−0.163	−0.500 **
Linear 20 m	−0.279	0.088	−0.113	−0.518 **
3 pt line sprint L	−0.040	−0.221	−0.250	−0.428 **
3 pt line sprint R	0.063	−0.325 *	−0.256	−0.388 *
505-L	−0.038	−0.068	−0.097	−0.059
505-R	0.164	−0.151	0.001	−0.168
CoDD-L	0.183	−0.171	−0.021	0.298
CoDD-R	0.384 *	−0.259	0.069	0.181
CMJ height	−0.112	0.293	0.194	1.000
CMJ RSI	0.223	−0.024	0.141	0.686 **
DJ height	0.000	0.092	0.087	0.724 **
DJ RSI	0.018	−0.040	−0.063	0.656 **

IMTP—isometric mid-thigh pull; CMJ—countermovement jump; PF—peak force; L—left; R—right; 3 pt—three-point; 505—change of direction test; CoDD—change of direction deficit, RSI—reactive strength index. * $p < 0.05$. ** $p < 0.01$.

3.2. Differences Between DSI Groups

We divided participants into three groups based on their DSI values. Nine participants were allocated in the high DSI group (>1.00), nine were in the low DSI group (<0.80), and twenty-four participants were in the middle group (0.80 < DSI < 1.00). No statistically significant differences in the homogeneity of variance existed among groups within the Levene's test were observed, and thus equal variances were assumed. Statistically significant differences were found between groups in IMPT peak force (F = 12.562; p < 0.001), horizontal jump (F = 5.621; p = 0.007), lateral jump (F = 7.753–9.503; p = 0.000–0.002) and specific lateral jump (F = 5.872–7.049; p = 0.000–0.002). Additional post hoc tests showed significant differences between high and low DSI groups (g = 1.66) and mid and low DSI groups (g = 1.93) in IMTP peak force. Regarding horizontal jump, the post hoc test showed a significant difference between the mid and low DSI groups (g = 1.34). In the lateral jump and basketball-specific lateral jump, the post hoc test showed a significant difference between the high and low DSI group (g = 0.89–1.37) and the mid and low DSI group (g = 1.28–1.70).

There were no differences between the groups regarding sprint and CoD performance (p = 0.073–0.996). Nevertheless, linear sprint results tended toward better performance in the high DSI group, while curvilinear results tended toward better performance in the low DSI group. Furthermore, for vertical jumps, ANOVA showed significant differences in CMJ height (F = 3.848; p = 0.030) and CMJ peak force (F = 5.489; p = 0.008), with no significant differences being observed in DJ parameters (F = 0.382–1.776; p = 0.183–0.685). Further post hoc tests revealed significant differences between the mid and low DSI group (g = 0.94) in CMJ height and between high and mid DSI groups in CMJ peak force (g = 1.22). The results for one-way ANOVA and post hoc tests are shown in the table below (Table 3).

Table 3. Results of one-way ANOVA.

Variable	High DSI Mean ± SD	Middle DSI Mean ± SD	Low DSI Mean ± SD	Hedges ' g			ANOVA	
				a	b	c	F	p
IMTP	2320 ± 419	2350 ± 319	3001 ± 359	−0.08	−1.66 *	−1.93 *	12.562	0.000
Horizontal jump	250 ± 14	240 ± 18	262 ± 8	0.57	−1.00	−1.34 *	5.621	0.007
Lateral jump L	177 ± 16	172 ± 14	196 ± 13	0.33	−1.24 *	−1.70 *	9.503	0.000
Lateral jump R	172 ± 16	170 ± 12	190 ± 13	0.15	−1.18 *	−1.59 *	7.753	0.002
Specific jump L	179 ± 18	179 ± 15	200 ± 10	0.00	−1.37 *	−1.48 *	7.049	0.002
Specific jump R	183 ± 14	177 ± 15	197 ± 16	0.40	−0.89	−1.28 *	5.872	0.006
Linear 10 m	1.71 ± 0.05	1.77 ± 0.08	1.74 ± 0.07	−0.79	−0.47	0.38	1.707	0.195
Linear 20 m	3.02 ± 0.14	3.07 ± 0.10	3.04 ± 0.10	−0.44	−0.16	0.29	0.767	0.472
Curvilinear—L 20 m	3.24 ± 0.10	3.33 ± 0.18	3.22 ± 0.13	−0.54	0.16	0.64	1.927	0.160
Curvilinear—R 20 m	3.30 ± 0.11	3.38 ± 0.18	3.23 ± 0.16	−0.47	0.48	0.83	2.820	0.073
505—L	2.24 ± 0.09	2.24 ± 0.11	2.24 ± 0.11	0.00	0.00	0.00	0.004	0.996
505—R	2.25 ± 0.08	2.25 ± 0.11	2.19 ± 0.11	−0.09	0.47	0.53	1.115	0.340
CoDD—L	0.53 ± 0.05	0.48 ± 0.13	0.50 ± 0.09	0.43	0.39	−0.16	0.473	0.627
CoDD—R	0.54 ± 0.05	0.49 ± 0.13	0.44 ± 0.09	0.43	1.30	0.40	1.704	0.198
CMJ height	0.39 ± 0.04	0.37 ± 0.07	0.43 ± 0.03	0.31	−1.08	−0.94 *	3.848	0.030
CMJ peak force	2547 ± 443	2123 ± 293	2237 ± 283	1.22 *	0.79	−0.38	5.489	0.008
RSI_{CMJ}	0.58 ± 0.12	0.49 ± 0.10	0.53 ± 0.05	0.83	0.52	−0.43	2.741	0.080
DJ height	0.34 ± 0.06	0.34 ± 0.06	0.36 ± 0.03	0.00	−0.40	−0.36	0.382	0.685
RSI_{DJ}	1.65 ± 0.29	1.52 ± 0.40	1.77 ± 0.19	0.34	−0.47	−0.68	1.776	0.183

DSI—dynamic strength index; SD—standard deviation; * statistical significant difference; a—effect size for high vs. mid DSI group, b—effect size for high vs. low DSI; c—effect size for mid vs. low DSI group; IMTP—isometric mid-thigh pull; L—left, R—right, 505—change of direction test, CoDD—change of direction deficit, CMJ—countermovement jump, RSI—reactive strength index, DJ—drop jump; *—statistically significant post hoc test.

4. Discussion

The aim of this study was to assess the associations between DSI and sprint, jump and CoD performance in highly trained basketball players and to determine the differences between the physical performance of athletes in different DSI groups (low, medium and high DSI groups). Correlation analysis showed weak to moderate associations between IMTP peak force and horizontal jump, lateral jump and curvilinear sprint, showing that maximal strength is likely one of the determinants of these abilities. No significant correlations were found between CMJ peak force and performance variables, while weak correlations were observed between the DSI and lateral jump, linear sprint and CoD deficit. Furthermore, our results showed that the low DSI group had the highest IMTP peak force, while the high DSI group had the highest CMJ peak force. The low DSI group showed better performance in vertical, horizontal and lateral jumps and also tended to exhibit better performance in the drop jump and curvilinear sprint tests than other groups. Linear sprints tended to be the best in the high DSI group, while all groups were aligned in CoD speed.

The novel findings of this study are the weak negative correlations between IMTP peak force and curvilinear sprint and weak-to-moderate correlations with lateral jumps, suggesting that strength ability might be important for basketball-specific sprint performance and the efficiency of lateral movements. Interestingly, this study did not observe significant associations between CoD ability and strength, although lower limb strength is reported to be one of the most important determinants of CoD ability [6]. Nevertheless, it must be mentioned that the CoDD variable showed poor absolute reliability (CV = 13.08–14.66%). Furthermore, a previous study also showed moderate associations between squat isometric peak force and CoD ability [16]. The lack of associations in the present study could be explained by the fact that the IMTP is not an isolated measure for lower limb strength but also challenges grip and core strength. Furthermore, negative associations between the DSI and lateral jumping suggest that lower DSI values indicate better lateral jumping ability, while negative associations between DSI and linear sprint suggest that a higher DSI score indicates superior sprint ability. Based on this, it seems that being strength-oriented is important for the ability to move in lateral directions, while being oriented towards ballistic force production is better for developing high sprint speeds in basketball players. Lastly, positive associations between the DSI and CoD deficit suggest that lower DSI scores indicate better CoD ability, supporting the importance of strength for CoD performance. This finding is consistent with the previous literature [16]. However, this must be further discussed in terms of DSI components. Since lower DSI values may reflect higher isometric peak force for the same ballistic peak force, the above correlations between the DSI and multi-directional jumping may be due to correlations between isometric peak force and jumps.

The low DSI group showed superior performance in jumps in all directions and tended to exhibit better performance in the drop jump (g = 0.36–0.40) and curvilinear sprint (g = 0.16–0.83) tests. Similar results have been reported in the literature in relation to jumping performance [30,31], showing that lower DSI values might be better for basketball players' physical performance, especially considering the importance of lateral movements, CoD and jumping capabilities [3,18]. Although all these qualities are to some extent determined by strength [27,41,42], these results suggest that a pure relationship between isometric and ballistic force may play a role in influencing the physical performance of basketball players. Nevertheless, it is important for practitioners to consider the relative effect of both components when interpreting DSI values to obtain better insight into players' neuromuscular characteristics, training adaptations and future training directions. It is important to interpret ratio numbers alongside their component parts for several reasons. First, ratio data typically show greater measurement error compared to their individual components [43,44]. This occurs because combining multiple components compounds the potential sources of error, which can reduce reliability [45]. In addition, when tracking changes in ratio data, the ratio score can change in multiple ways, not all of which are beneficial. For instance, in the context of DSI, if both components decrease proportionally, the DSI score may remain stable. This stability might misleadingly suggest that no adaptation has occurred when, in reality, performance would likely decline due to reduced strength and ballistic capacities.

Previous studies have shown that basketball players have the highest DSI scores among male collegiate team athletes [17], with studies suggesting that the average DSI value in basketball players is ~0.90 [11,16,17]. Our study shows similar results with an average DSI value of 0.91 and ranging from 0.60 to 1.22. Previous research by Suchomel et al. (2020b) reported very strong associations between DSI and IMPT peak force ($r = -0.746$), while small associations were reported between DSI and CMJ peak force ($r = 0.297$), showing that the IMTP peak force has more bearing on the resultant DSI ratio compared to the CMJ. Based on this, high DSI scores in basketball players may be viewed as a lack of strength ability, which is also supported by similar studies showing that basketball players are more velocity-oriented and/or force-deficient [46]. Thus, high DSI values in basketball can also be, to some extent, justified by the ballistic nature of the sport itself. Basketball is known as a "stop and go" sport due to many accelerations, decelerations and CoDs [18]; thus, it seems that basketball players have to develop force in a ballistic manner (jumps and accelerations) or absorb the high magnitude of force in a short time period (deceleration and CoDs). A previous study reported a decrease in DSI scores in subjects with high DSI scores after 4 weeks of strength and power training [10]. Additionally, a recent study on basketball players showed that training based on DSI is superior for improving physical performance compared to general resistance training [11]. Together with the results of this study, it seems that DSI is sensitive to detecting specific neuromuscular deficits, based on which training-related decision can be made, to improve the physical performance of basketball players. Although additional studies are needed to determine the precise benchmarks for navigating training based on DSI values, it is reasonable to assume that maximal strength is an important quality for the physical performance of basketball players.

The results of this study show some weak correlations between DSI and performance metrics. As discussed in the previous paragraphs, readers must acknowledge the limitations of the ratio. An additional critique and potential reason for the weak correlations could be the selection of peak force in CMJ peak force as a component metric. DSI is originally consisting of CMJ and IMPT peak force [13]. IMTP peak force is considered a strength ability and presents an individual's maximal force-generating capacity, while the use of CMJ peak force for presenting dynamic force capacity can be a bit questionable. It was previously reported that CMJ peak force does not directly equate to jump height, take-off velocity and net impulse [47] or may even be at odds with those metrics [48] and thus may not be the best metric to represent ballistic capacity. This could also be the reason for the absence of correlations between CMJ peak force and performance metrics, while CMJ jump height showed moderate associations with all performance tests except CoD ability. Therefore, alternative forms of the DSI calculated from time-limited jump metrics suggested by James and Comfort (2022) [49] may be more suitable to reflect fast dynamic strength capabilities as they underpin jump performance to a greater extent than peak force [48]. In summary, more studies are needed to obtain insight into how alternative forms of DSI influence general physical performance and detect training adaptations and whether any of them can be used to navigate training-related decisions.

Some limitations of the study must be acknowledged. First, the relatively small sample size ($n = 44$) limits the statistical power of the analyses and increases the likelihood of Type 1 errors. While the sample was sufficient to detect moderate correlations ($r > 0.40$) with 80% power at an alpha level of 0.05, the multiple correlations performed increased the probability of false positives. Although the low DSI group showed superior results compared to the other two groups, these results must be interpreted with caution as the low

DSI group exhibited significantly higher strength ability based on the IMTP data compared to the other two groups. In addition, this is a cross-sections study, meaning that results may change during the basketball season. More surveys during the season would be needed for a more reliable assessment and relationship between DSI and the physical performance of basketball players. Finally, the sample studied was very homogeneous (i.e., highly trained male basketball players); thus, the results cannot be generalized to performance metrics and athletes from other sports.

Practical Application

- DSI may present a useful method to detect neuro-muscular characteristics of basketball players;
- DSI seems to be easy to apply in high-level sports, thus may also be used during the competitive season to follow neuro-muscular adaptations;
- basketball is predominantly ballistic-oriented in its nature; thus, more maximal strength training may be required to improve the physical performance of basketball players.

5. Conclusions

Our results showed that lower DSI values may be desired for the physical performance of basketball players. DSI suggests that due to the ballistic nature of basketball, more maximal strength training is required to optimize the DSI ratio. This was additionally supported by significant associations between maximal strength with multi-directional jumping and curvilinear sprint performance. Furthermore, due to significant correlations between DSI with linear sprint and CoD ability, it seems that a pure relationship between isometric and ballistic force may play a role in influencing the physical performance of basketball players. Nevertheless, caution is needed when interpreting DSI values, as it is recommended to consider the relative effect of both components to obtain better insight into players' neuromuscular characteristics, training adaptations and future training direction.

Author Contributions: Conceptualization, J.P., Ž.K. and N.Š.; methodology, J.P., F.U. and C.B.; software, J.P.; validation, Ž.K., N.Š. and C.B.; formal analysis, J.P. and F.U.; investigation, J.P.; resources, Ž.K.; data curation, J.P.; writing—original draft preparation, J.P.; writing—review and editing, F.U., C.B., N.Š. and Ž.K.; visualization, J.P.; supervision, Ž.K. and N.Š.; project administration, Ž.K.; funding acquisition, N.Š. All authors have read and agreed to the published version of the manuscript.

Funding: The authors acknowledge the support by the Slovenian Research Agency through the research program KINSPO—Kinesiology for the effectiveness and prevention of musculoskeletal injuries in sports (P5-0443). The funder played no role in study conceptualization, data collection and preparation of the manuscript.

Institutional Review Board Statement: The protocol was conducted in accordance with the latest revision of the Declaration of Helsinki. The experimental procedures were reviewed and approved Slovenian Medical Ethics Committee (approval no. 0120-99/2018/5).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors on reasonable request. The data cannot be publicly available because players could be potentially identified from data other than name and surname.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. García, F.; Fernández, D.; Illa, J.; Reche, X.; Font, R.; Guitart, M.; Pla, F.; Tarragó, J.R.; Vázquez-Guerrero, J. Comparing the Most Demanding Scenarios of Official Matches across Five Different Professional Team Sports in the Same Club. *Apunts Sports Med.* **2022**, *57*, 100390. [CrossRef]
2. Svilar, L.; Castellano, J.; Jukić, I.; Casamichana, D. Positional Differences in Elite Basketball: Selecting Appropriate Training-Load Measures. *Int. J. Sports Physiol. Perform.* **2018**, *13*, 947–952. [CrossRef] [PubMed]
3. Stojanović, E.; Stojiljković, N.; Scanlan, A.T.; Dalbo, V.J.; Berkelmans, D.M.; Milanović, Z. The Activity Demands and Physiological Responses Encountered During Basketball Match-Play: A Systematic Review. *Sports Med.* **2018**, *48*, 111–135. [CrossRef]
4. Salazar, H.; Pleša, J.; Svilar, L.; Ujaković, F. Elite Basketball Game External Load Varies between Different Teams and Competition. *Kinesiology* **2024**, *56*, 145–152. [CrossRef]
5. Morrison, M.; Martin, D.T.; Talpey, S.; Scanlan, A.T.; Delaney, J.; Halson, S.L.; Weakley, J. A Systematic Review on Fitness Testing in Adult Male Basketball Players: Tests Adopted, Characteristics Reported and Recommendations for Practice. *Sports Med.* **2022**, *52*, 1491–1532. [CrossRef] [PubMed]
6. Dos'Santos, T.; Thomas, C.; McBurnie, A.; Comfort, P.; Jones, P.A. Biomechanical Determinants of Performance and Injury Risk During Cutting: A Performance-Injury Conflict? *Sports Med.* **2021**, *51*, 1983–1998. [CrossRef]
7. Riggs, M.P.; Sheppard, J.M. The Relative Importance of Strength and Power Qualities to Vertical Jump Height of Elite Beach Volleyball Players during the Counter-Movement and Squat Jump. *J. Hum. Sport Exerc. (JHSE)* **2009**, *4*, 221–236. [CrossRef]
8. Spiteri, T.; Nimphius, S.; Hart, N.H.; Specos, C.; Sheppard, J.M.; Newton, R.U. Contribution of Strength Characteristics to Change of Direction and Agility Performance in Female Basketball Athletes. *J. Strength Cond. Res.* **2014**, *28*, 2415–2423. [CrossRef] [PubMed]
9. Sheppard, J.M.; Chapman, D.; Taylor, K.-L. An Evaluation of a Strength Qualities Assessment Method for the Lower Body. *J. Aust. Strength Cond.* **2011**, *19*, 4–10.
10. Comfort, P.; Thomas, C.; Dos'Santos, T.; Suchomel, T.; Jones, P.; McMahon, J. Changes in Dynamic Strength Index in Response to Strength Training. *Sports* **2018**, *6*, 176. [CrossRef] [PubMed]
11. Pleša, J.; Ujaković, F.; Ribič, A.; Bishop, C.; Šarabon, N.; Kozinc, Ž. Effectiveness of an Individualized Training Based on Dynamic Strength Index on Sprinting, Jumping and Change of Direction Performance in Basketball Players: A Randomized Controlled Trial. *J. Sports Sci. Med.* **2024**, *23*, 504. [CrossRef]
12. Suchomel, T.J.; Sole, C.J.; Bellon, C.R.; Stone, M.H. Dynamic Strength Index: Relationships with Common Performance Variables and Contextualization of Training Recommendations. *J. Hum. Kinet.* **2020**, *74*, 59–70. [CrossRef]
13. Thomas, C.; Jones, P.A.; Comfort, P. Reliability of the Dynamic Strength Index in College Athletes. *Int. J. Sports Physiol. Perform.* **2015**, *10*, 542–545. [CrossRef] [PubMed]
14. Comfort, P.; Thomas, C.; Dos'Santos, T.; Jones, P.A.; Suchomel, T.J.; McMahon, J.J. Comparison of Methods of Calculating Dynamic Strength Index. *Int. J. Sports Physiol. Perform.* **2018**, *13*, 320–325. [CrossRef] [PubMed]
15. Young, K.P.; Haff, G.G.; Newton, R.U.; Sheppard, J.M. Reliability of a Novel Testing Protocol to Assess Upper-Body Strength Qualities in Elite Athletes. *Int. J. Sports Physiol. Perform.* **2014**, *9*, 871–875. [CrossRef] [PubMed]
16. Pleša, J.; Ujaković, F.; Bishop, C.; Kozinc, Ž.; Šarabon, N. Dynamic Strength Index in Basketball Players: Age and Position Differences, Seasonal Variation and Association with Sprinting and Change of Direction Performance. *J. Sci. Sport Exerc.* **2023**. [CrossRef]
17. Thomas, C.; Dos'santos, T.; Jones, P.A. A Comparison of Dynamic Strength Index between Team-Sport Athletes. *Sports* **2017**, *5*, 71. [CrossRef] [PubMed]
18. Svilar, L.; Jukić, I. Load Monitoring System in Top-Level Basketball Team. *Kinesiology* **2018**, *50*, 25–33. [CrossRef]
19. Heishman, A.D.; Curtis, M.A.; Saliba, E.N.; Hornett, R.J.; Malin, S.K.; Weltman, A.L. Comparing Performance During Morning vs. Afternoon Training Sessions in Intercollegiate Basketball Players. *J. Strength Cond. Res.* **2017**, *31*, 1557–1562. [CrossRef] [PubMed]
20. Rauch, J.; Leidersdorf, E.; Reeves, T.; Borkan, L.; Elliott, M.; Ugrinowitsch, C. Different Movement Strategies in the Countermovement Jump Amongst a Large Cohort of NBA Players. *Int. J. Environ. Res. Public Health* **2020**, *17*, 6394. [CrossRef] [PubMed]
21. Petway, A.J.; Freitas, T.T.; Calleja-González, J.; Medina Leal, D.; Alcaraz, P.E. Training Load and Match-Play Demands in Basketball Based on Competition Level: A Systematic Review. *PLoS ONE* **2020**, *15*, e0229212. [CrossRef]
22. Jeffreys, M.A.; De Ste Croix, M.B.A.; Lloyd, R.S.; Oliver, J.L.; Hughes, J.D. The Effect of Varying Plyometric Volume on Stretch-Shortening Cycle Capability in Collegiate Male Rugby Players. *J. Strength Cond. Res.* **2019**, *33*, 139–145. [CrossRef] [PubMed]

23. Petway, A.J.; Freitas, T.T.; Calleja-González, J.; Alcaraz, P.E. Match Day-1 Reactive Strength Index and In-Game Peak Speed in Collegiate Division I Basketball. *Int. J. Environ. Res. Public Health* **2021**, *18*, 3259. [CrossRef] [PubMed]
24. Xie, T.; Crump, K.B.; Ni, R.; Meyer, C.H.; Hart, J.M.; Blemker, S.S.; Feng, X. Quantitative Relationships Between Individual Lower-Limb Muscle Volumes and Jump and Sprint Performances of Basketball Players. *J. Strength Cond. Res.* **2020**, *34*, 623–631. [CrossRef] [PubMed]
25. Shalfawi, S.A.; Sabbah, A.; Kailani, G.; Tønnessen, E.; Enoksen, E. The Relationship Between Running Speed and Measures of Vertical Jump in Professional Basketball Players: A Field-Test Approach. *J. Strength Cond. Res.* **2011**, *25*, 3088–3092. [CrossRef]
26. Sugiyama, T.; Maeo, S.; Kurihara, T.; Kanehisa, H.; Isaka, T. Change of Direction Speed Tests in Basketball Players: A Brief Review of Test Varieties and Recent Trends. *Front. Sports Active Living* **2021**, *3*, 645350. [CrossRef] [PubMed]
27. Baena-Raya, A.; Díez-Fernández, D.M.; López-Sagarra, A.; Martínez-Rubio, C.; Soriano-Maldonado, A.; Rodríguez-Pérez, M.A. Novel Curvilinear Sprint Test in Basketball: Reliability and Comparison With Linear Sprint. *J. Strength Cond. Res.* **2023**, *37*, e535–e540. [CrossRef] [PubMed]
28. Ben Abdelkrim, N.; El Fazaa, S.; El Ati, J.; Tabka, Z. Time-Motion Analysis and Physiological Data of Elite under-19-Year-Old Basketball Players during Competition * Commentary. *Br. J. Sports Med.* **2007**, *41*, 69–75. [CrossRef]
29. Conte, D.; Favero, T.G.; Lupo, C.; Francioni, F.M.; Capranica, L.; Tessitore, A. Time-Motion Analysis of Italian Elite Women's Basketball Games: Individual and Team Analyses. *J. Strength Cond. Res.* **2015**, *29*, 144–150. [CrossRef] [PubMed]
30. McMahon, J.J.; Jones, P.A.; Dos'santos, T.; Comfort, P. Influence of Dynamic Strength Index on Countermovement Jump Force-, Power-, Velocity-, and Displacement-Time Curves. *Sports* **2017**, *5*, 72. [CrossRef] [PubMed]
31. Secomb, J.L.; Nimphius, S.; Farley, O.R.L.; Lundgren, L.; Tran, T.T.; Sheppard, J.M. Lower-Body Muscle Structure and Jump Performance of Stronger and Weaker Surfing Athletes. *Int. J. Sports Physiol. Perform.* **2016**, *11*, 652–657. [CrossRef]
32. Parsonage, J.; Secomb, J.; Dowse, R.; Ferrier, B.; Sheppard, J.; Nimphius, S. The Assessment of Isometric, Dynamic, and Sports-Specific Upper-Body Strength in Male and Female Competitive Surfers. *Sports* **2018**, *6*, 53. [CrossRef] [PubMed]
33. Hulley, S.B.; Cummings, S.R.; Browner, W.S.; Grady, D.; Newman, T.B. *Designing Clinical Research: An Epidemiologic Approach*, 4th ed.; Lippincott Williams & Wilkins: Philadelphia, PA, USA, 2013; Volume 2013, p. Appendix 6C 79.
34. Nimphius, S.; Callaghan, S.J.; Bezodis, N.E.; Lockie, R.G. Change of Direction and Agility Tests: Challenging Our Current Measures of Performance. *Strength Cond. J.* **2018**, *40*, 26–38. [CrossRef]
35. Ebben, W.P.; Petushek, E.J. Using the Reactive Strength Index Modified to Evaluate Plyometric Performance. *J. Strength Cond. Res.* **2010**, *24*, 1983–1987. [CrossRef]
36. Dos'Santos, T.; Thomas, C.; Jones, P.A.; McMahon, J.J.; Comfort, P. The Effect of Hip Joint Angle on Isometric Midthigh Pull Kinetics. *J. Strength Cond. Res.* **2017**, *31*, 2748–2757. [CrossRef] [PubMed]
37. Koo, T.K.; Li, M.Y. A Guideline of Selecting and Reporting Intraclass Correlation Coefficients for Reliability Research. *J. Chiropr. Med.* **2016**, *15*, 155–163. [CrossRef] [PubMed]
38. Hopkins, W.G.; Marshall, S.W.; Batterham, A.M.; Hanin, J. Progressive Statistics for Studies in Sports Medicine and Exercise Science. *Med. Sci. Sports Exerc.* **2009**, *41*, 3–12. [CrossRef] [PubMed]
39. Akoglu, H. User's Guide to Correlation Coefficients. *Turk. J. Emerg. Med.* **2018**, *18*, 91–93. [CrossRef] [PubMed]
40. Lakens, D. Calculating and Reporting Effect Sizes to Facilitate Cumulative Science: A Practical Primer for *t*-Tests and ANOVAs. *Front. Psychol.* **2013**, *4*, 863. [CrossRef] [PubMed]
41. Furlong, L.-A.M.; Harrison, A.J.; Jensen, R.L. Measures of Strength and Jump Performance Can Predict 30-m Sprint Time in Rugby Union Players. *J. Strength Cond. Res.* **2021**, *35*, 2579–2583. [CrossRef] [PubMed]
42. Jarvis, P.; Turner, A.; Read, P.; Bishop, C. Reactive Strength Index and Its Associations with Measures of Physical and Sports Performance: A Systematic Review with Meta-Analysis. *Sports Med.* **2022**, *52*, 301–330. [CrossRef] [PubMed]
43. Bishop, C. Using Ratio Data in Strength and Conditioning: Component Parts Hold the Key. *J. Strength Cond. Res.* **2024**, *2024*.
44. Bishop, C.; Shrier, I.; Jordan, M. Ratio Data: Understanding Pitfalls and Knowing When to Standardise. *Symmetry* **2023**, *15*, 318. [CrossRef]
45. Bishop, C.; Read, P.; Lake, J.; Loturco, I.; Turner, A. A Novel Approach for Athlete Profiling: The Unilateral Dynamic Strength Index. *J. Strength Cond. Res.* **2021**, *35*, 1023–1029. [CrossRef]
46. Ramirez-Campillo, R.; García-Hermoso, A.; Moran, J.; Chaabene, H.; Negra, Y.; Scanlan, A.T. The Effects of Plyometric Jump Training on Physical Fitness Attributes in Basketball Players: A Meta-Analysis. *J. Sport Health Sci.* **2022**, *11*, 656–670. [CrossRef] [PubMed]
47. Kawamori, N.; Rossi, S.J.; Justice, B.D.; Haff, E.E.; Pistilli, E.E.; O'Bryant, H.S.; Stone, M.H.; Haff, G.G. Peak Force and Rate of Force Development During Isometric and Dynamic Mid-Thigh Clean Pulls Performed at Various Intensities. *J. Strength Cond. Res.* **2006**, *20*, 483. [CrossRef]

48. Brearley, S.; Buckthorpe, M.; Xu, J.; Bishop, C. The Dynamic Strength Index: Is It a Useful Tool to Guide Programming Decisions? *Prof. Strength Cond.* **2024**, *2024*. Preprint. Available online: https://www.researchgate.net/publication/380290804_The_Dynamic_Strength_Index_Is_it_a_Useful_Tool_to_Guide_Programming_Decisions (accessed on 20 December 2024).
49. James, L.P.; Comfort, P. The Reliability of Novel, Temporal-Based Dynamic Strength Index Metrics. *Sports Biomech.* **2022**, 1–12. [CrossRef]