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ORIGINAL RESEARCH

Correlation between linear speed, change of direction speed and dribble deficit in male handball players

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Abstract

The aim of this study was to determine the relationship between linear sprint and change of direction (COD) speed using the novel approach of the Dribble Deficit (DD) among professional handball players. This study included 14 male professional handball players (age = 23.1 ± 3.43). Each player performed the following tests: a 10, 20 and 30 meter linear sprint; a zig-zag test; a slalom test and 4 × 5 agility test with and without a ball. A significant correlation was found between the DD at 10 m and the 10 m sprint with the ball ($p < 0.05$, r = 0.575). Additionally, the results showed that the values of dribble deficit during slalom test were related ($p < 0.01$) to the 20-m sprint with the ball (r = 0.767), the 30-m sprint with a ball (r = 0.765) and the slalom with a ball (r = 0.938). Regression analyses showed significant influence of the linear sprint at 10 m on DD ($p = 0.02$, $R^2 = 0.373$), and the zig-zag test without ball on the DD ($p = 0.004$, $R^2 = 0.514$). The results suggest that the linear sprint and zig-zag test used to evaluate COD movement speed are associated with and influence DD in professional handball players. Further research on DD is necessary in order to determine that DD is not influence by physical performance and how we can use it in the future to calculate the time required for dribbling.

Keywords

Specific skills; Technique; Agility

1. Introduction

Handball is sport a high-intensity sport where have frequently changed intensity, transitions defensive and offensive actions which require a high level of physical and technical abilities of the players [1]. During a match, the players are involved in high-intensity activities over short intervals, which suggests that they frequently perform explosive technical elements such as catching, passing, shooting, and Dribbling [2]. Dribbling is one of the basic techniques in the game of handball. Players can master it by dribbling the opponent player in order to maintain the ball's position and avoid being captured by the opponents [3]. On average, handball players perform 10–12 Dribbles per game [4], which is significantly less than other team sports with the ball. Specific skills in handball are one of the most important factors that have a direct impact on the quality of handball players and match outcomes [5]. Dribbling is a valuable skill that handball players need to master, and acquiring this skill greatly contributes to the game [3, 6]. Furthermore, Dribbling skills are widely used as a measurement of talent identification and early sports development [7]. Thus, Dribbling skills are a very important parameter in handball despite their moderate application during match play. A player usually resorts to dribbling when he has no open teammate in sight to whom he could pass the ball, as well as during counter-attacks and semi-counter-attacks, where dribbling is especially prominent [6]. Given the importance of dribbling during low- to high-intensity actions, coaches and practitioners should have an efficiency assessment tool that can differentiate between dribble speed and sprint speed [2].

Traditionally, dribbling speed has been measured in team sports as total performance time with a ball over different distances, in both linear and change of direction (COD) movement patterns [8]. However, previous studies [8] have found that dribbling speed is significantly influenced by the player's running and sprinting performance without the ball. More precisely, players with a higher sprinting performance may exhibit superior performance in tests using total dribbling time, irrespective of dribbling proficiency [9]. In research [10, 11] it was hypothesized sprint speed and total dribble performance time would exhibit high shared variance, and sprint speed and Dribble Deficit (DD) would possess low shared variance. There are not any studies about DD in handball players that can confirm these results. Therefore, a novel approach for measuring dribbling speed independently of sprinting speed is necessary for handball. Recently, Scanlan *et al.* [8] introduced the DD in basketball as a novel and more important measure of dribbling speed that effectively isolates the running and sprinting performance. The results of the DD will be greater if there is a greater difference between the linear sprint results or the COD movement sprint and the Dribble with a ball results.

To date, the DD has been investigated only in semi-professional [8] and collegiate [9] male basketball players. Both studies have concluded that the DD is a more isolated measure of dribbling speed due to non-significant trivial to moderate relationships between sprint speed and the DD across linear and COD movement patterns [8]. Consequently, the DD represents an additional measurement of dribbling speed that assesses dribbling speed independent of sprint speed in test batteries [9]. However, handball practitioners and sports scientists still use the traditional approach to assess players' dribbling performance, with less attention given to the DD as the novel and more precise method. At the moment, the DD in handball has not been established, which raises the question of the relationship between dribbling and sprint speed. Therefore, this study aimed to determine the relationship between dribbling speed and sprint across linear and COD movement patterns using the novel approach of the DD and the traditional approach of total dribbling performance time among professional handball players.

2. Materials and methods

2.1 Participants

A total of 14 professional handball players were included in this study (age: 23.1 ± 3.43) and their measures of body composition are shown in Table 1. Participants were members of the same team competing in the Serbian Super League and international competitions (SEHA League, EHF Challenge Cup). The participants were in a competitive training cycle with 7–8 training sessions per week and one match.

TABLE 1. Descriptive measures body composition.

Variable	Mean ± SD
Height (cm)	198.44 ± 8.44
Body mass (kg)	91.58 ± 17.25
BMI	25.39 ± 3.12
Body fat	20.96 ± 5.52
Visceral Fat	6.29 ± 2.92

BMI: body mass index; Mean: mean; SD: standard deviation.

The sample size is similar to those from transversal studies in which members of the same teams were examined [12, 13] and meets the G*Power criteria (version 3.1.9.2; University of Düsseldorf; Düsseldorf, Germany) (alpha = 0.05; beta = 0.80; coefficient of determination = 0.5). The value of the coefficient of determination of 0.5 was chosen as the basis against which different tests can be identified that assess similar traits [14] and is thereby compatible with the relationships established between similar deficit measures (such as Change-of-Direction Deficit) and the time required for the change-of-direction [15].

2.2 Procedure

A cross-sectional study design was used in this research. At the beginning, body height, body weight, BMI (body mass index), and age were measured for each participant. Body height was measured using an anthropometer (Seca 220; Seca Corporation, Hamburg, Germany), and the result was read with an accuracy of 0.1 cm, while body weight and BMI were measured using an InBody 770 digital scale (InBody 770; Biospace Co. Ltd., Seoul, Korea), with an accuracy of 0.1 kg of body weight. Before the testing procedures, the participants did a 20-minute standardized warm-up. The warm-up consisted of dynamic stretching, low-intensity jogging, and short accelerations and decelerations. After warming up, there was a break of 2–3 minutes, and then each player performed each test three times, once without and once with the ball. If there was an irregularity while performing tests, the participant would be returned to the starting position with a passive rest of 2 minutes until the next performance. All participants had a break of 5–6 minutes between different testing sessions. The participants were not allowed to have any activities during the resting periods and it was ensured that participants were familiar with procedures. Testing was done in the afternoon on an indoor, hardwood handball court. The participants were also informed in a timely manner that they must not engage in any physical activity or use illicit stimulants for two days before the test and that they must not eat for three hours before the test. During the testing protocol, they used water or other refreshments to rehydrate the body. The warm-up and testing procedure were carried out by a sports science researcher.

Each test was done without the ball, and then with the ball. When performing a test with linear dribbling, the participants did it with their dominant hand. When performing COD tests, the participants started to dribble the ball with their dominant hand; however, they were instructed to transfer the ball to the non-dominant hand when bypassing the cones, so the ball was always dribbled from the outside of the cone. Before the assessments, all points were precisely marked, and electric gates were placed on the start and finish lines (Witty, Microgate, Italy). Only during the linear sprinting test were two additional gates placed in order to determine the passing time at 10 m and 20 m. The participants were 30 m away from the starting line, so they could not start the timing mechanism too early [15]. Each participant started to perform each test at their own will, when they were completely ready. Moreover, all participants were encouraged to perform each test with maximal effort [8, 16]. For tests with the ball, a standardized competition ball for male handball players (brand Molten HX5001-BW, size 3) was used and they were allowed to use stickum.

2.3 Measures

The 30-meter straight-line sprint is a similar one that has been applied before [8, 17, 18] to determine the speed of a straight-line run. Results are recorded in seconds.

In the zig-zag test (Fig. 1), handball players ran at maximum speed with changes of direction at 5 meters for the assessment of agility [19]. Results are recorded in seconds.

In the slalom test (Fig. 2), six cones were placed. Only the first cone was 1 m away from the starting line, while the distance between the other 5 was 2 m. The participants start from the starting line and bypass all cones alternately (the participant who leads the ball with his right hand bypasses the first cone on the right, then the next one on the left, while the left-handed participants do all the opposite) to the last conus, and then turns 180º and runs slalom back by running slalom to the starting line [20]. Results are recorded in seconds.

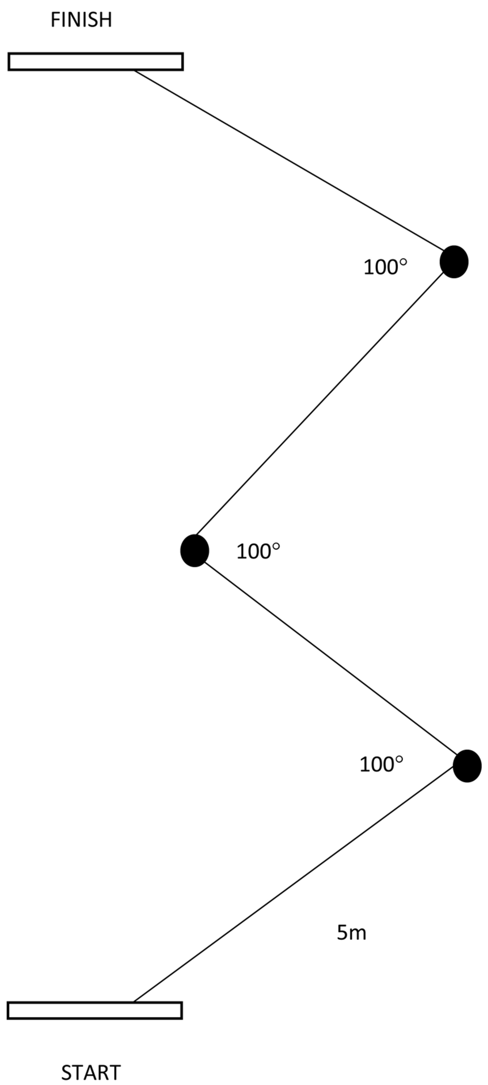

FIGURE 1. Zig-zag test.

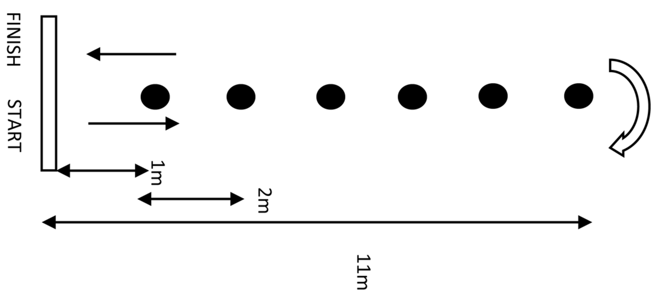

FIGURE 2. Slalom test.

In the test, 4 × 5 m (Fig. 3) with a constant change of direction need to cross at maximum run speed. The participants start from the starting line, or from point A, by running a 5 m straight line sprint to point B, then bypass the cone and change the direction of movement by 90º to point C, where once again they bypass the cone by 90º and run to point D, then bypass the mentioned point by 180º and sprint through the target line marked by point E [20]. Results are recorded in seconds.

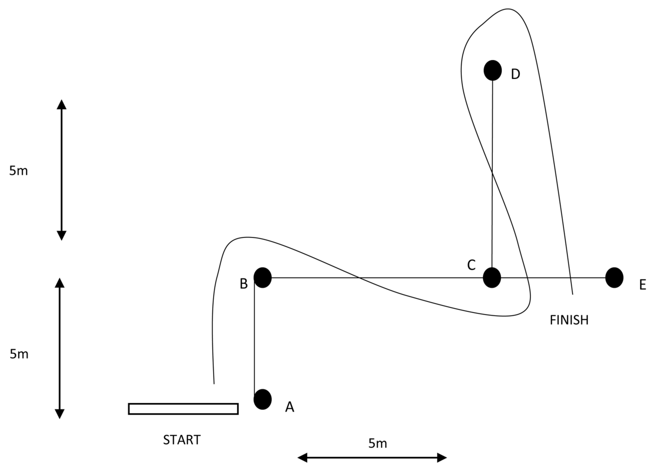

FIGURE 3. 4 × 5 agility tests.

2.4 Dribble deficit

The differences between the best result in dribbling and the best result in the test without dribbling for a straight line sprint and a sprint with a change of direction of movement were calculated in order to determine the DD. DD is determined by the time added to the sprint (straight line and sprint with a change of direction) in accordance with the requirements of proper dribbling described in the test description. A similar methodology has previously been applied in team sports to determine the time added when changing direction of movement or the deficit in change of direction [15]. The relative dribble deficit (%) was calculated as the dribble deficit divided by the time for the test without dribbling for a straight-line sprint and a sprint with a change of direction.

2.5 Statistical analysis

The data were processed by the Statistical Package for Social Sciences (SPSS) (v19.0, SPSS Inc., Chicago, IL, USA). A Pearson's two-tailed correlation was used to calculate relationships between the dribbling deficit without and with the ball on linear speed tests and COD tests. Linear regression analysis was conducted to determine the shared variance (R^2) between dribbling speed and sprint across linear and COD movement patterns using the novel approach of the Dribble Deficit and the traditional approach of total dribbling performance time.

3. Results

The basic descriptive statistic parameters, the means, and the standard deviation for each of the studied variables are shown in Table 2.

Table 3 shows the results of the correlation between the values of the DD and other variables. A significant negative correlation was found between the DD at 10 m and the linear sprint at 10 m ($p < 0.05$, $r = -0.61$). It also showed a

TABLE 2. Descriptive statistics of the handball players' physical performance (N = 14).

Variable	Mean ± SD	95% CI	
		Lower	Upper
10 m sprint	2.01 ± 0.12	1.94	2.08
20 m sprint	3.33 ± 0.14	3.25	3.41
30 m sprint	4.60 ± 0.19	4.50	4.72
10 m sprint with a ball	2.09 ± 0.12	2.02	2.16
20 m sprint with a ball	3.49 ± 0.16	3.39	3.58
30 m sprint with a ball	4.83 ± 0.27	4.68	4.99
slalom without ball	6.62 ± 0.32	6.43	6.80
slalom with ball	7.68 ± 0.89	7.17	8.20
Zig-zag without ball	5.24 ± 0.25	5.10	5.39
Zig-zag with a ball	5.47 ± 0.18	5.36	5.57
4 × 5 without ball	6.25 ± 0.28	6.09	6.41
4 × 5 with a ball	6.46 ± 0.43	6.21	6.70
Dribble deficit 10 m	0.08 ± 0.14	0.01	0.16
Dribble deficit 20 m	0.16 ± 0.14	0.07	0.24
Dribble deficit 30 m	0.23 ± 0.23	0.10	0.36
Dribble deficit COD	1.07 ± 0.77	0.62	1.51
Dribble deficit Zig-zag	0.22 ± 0.18	0.12	0.33
Dribble deficit 4 × 5 m	0.21 ± 0.35	0.01	0.41

BMI: body mass index; SD: standard deviation; 95% CI: 95% confidence intervals; COD: change of direction.

TABLE 3. Correlation parameters between DD and physical performance.

	Dribble deficit 10 m	Dribble deficit 20 m	Dribble deficit 30 m	Dribble deficit slalom	Dribble deficit zig-zag	Dribble deficit 4 × 5 m
10 m sprint	−0.610*	−0.544*	−0.441	0.217	−0.200	0.022
20 m sprint	−0.420	−0.374	−0.342	0.393	−0.350	0.092
30 m sprint	−0.114	−0.088	−0.168	0.586*	−0.434	0.126
10 m sprint with a ball	0.575*	0.528	0.259	0.450	−0.214	0.006
20 m sprint with a ball	0.430	0.557*	0.401	0.767**	−0.198	0.309
30 m sprint with a ball	0.414	0.599*	0.716**	0.765**	−0.145	0.341
slalom without ball	−0.182	−0.297	−0.307	0.218	−0.009	−0.104
slalom with a ball	0.097	0.294	0.251	0.938**	0.052	0.500
Zig-zag without ball	−0.143	−0.200	−0.272	0.251	−0.717**	0.000
Zig-zag with a ball	−0.212	−0.155	−0.192	0.426	−0.012	0.273
4 × 5 without ball	−0.134	−0.248	−0.313	0.234	−0.326	−0.097
4 × 5 with a ball	−0.100	0.046	0.041	0.666**	0.007	0.756**

**Correlation is significant at the 0.05 level; **Correlation is significant at the 0.01 level.*

statistically significant relationship with a 10-meter sprint with a ball ($p < 0.05$, r = 575). DD 20 m showed a negative association with 10 m sprint ($p < 0.05$, r = −0.544), while values of association with 30 m sprint with a ball were ($p < 0.05$, r = 0.599). The correlation results showed that the values of DD slalom were mostly related to other variables with statistically significant results ($p < 0.01$) with 20-m sprints with a ball (r = 0.767), 30-m sprints with a ball (r = 0.765), 4 × 5 with a ball (r = 0.666), and slalom with a ball (r = 0.938). The statistically significant correlation between the zig-zag test without a ball and the zig-zag test DD was ($p < 0.01$; r = −0.717). In the test DD 4 × 5 there is a statistically significant correlation with the test 4 × 5 without a ball ($p < 0.01$; r = 0.756).

Regression analysis yielded a significant influence of the 10 m linear sprint on the DD at 10 m ($p = 0.02$, $R^2 = 0.373$, Fig. 4a). This was not the case for the 10 m linear sprint and the 10 m linear sprint with a ball ($p > 0.05$, $R^2 = 0.088$, Fig. 4b).

Regression analysis yielded statistically significant impact results for the variables used to estimate velocity for the change of direction: the zig-zag test without the ball and the zig-zag test DD ($p = 0.004$, $R^2 = 0.514$, Fig. 5a). Significant impact was also found for zig-zags without balls and zig-zags with balls ($p = 0.005$, $R^2 = 0.498$, Fig. 5b).

4. Discussion

The aim of this study was to determine the correlation between Dribble speed and sprint across linear and COD movement patterns using the novel approach of the DD and the traditional approach of total Dribble performance time among professional handball players. Our results on correlation have shown in those tests a line sprint with ball and a frequent relationship with dribbling deficit tests. Similar results have indicated [21] that among athletes there is a correlation between 30-meter dribbling and linear sprints. The authors also talk about is there the relationship between linear sprint 10 m and COD values for young handball players, whether results on straight line running are correlated with COD [22], whose research argues that there is a significant correlation ($p < 0.05$, r = 0.36), and whose results agree with ours. In senior handball players, these abilities show a connection in values ($p = 0.002$; r = 0.580) [23]. Some studies researched the correlation between the linear sprint and the total Dribble time with the dominant hand at senior basketball players and determined that there was a statistically significant correlation between the two [9]. These results are confirmed [8], where it is determined that there is a significant correlation between the linear sprint and the total Dribble time with the dominant hand ($p = 0.010$, r = 0.77, $R^2 = 0.59$), but not for the values of the linear sprint and the linear DD ($p = 0.675$, R = 0.15, $R^2 = 0.02$).

As in the previous research, DD with the dominant hand and linear sprint showed no significant correlation [9]. Our results of the DD Slalom Test indicate that there is a correlation with COD tests without the ball. Somewhat different results were obtained by Ramirez-Campillo *et al.* [9], which indicate that there is a significant influence of COD sprint on Dribble time (r = 0.91, $R^2 = 0.82$, $p < 0.001$) but not for the variables COD sprint time and the COD DD (r = −0.23, $R^2 = 0.05$, $p = 0.530$). In the semi-professional basketball players, the COD movement time and total Dribble time have a strong correlation ($p = 0.002$, r = 0.88, $R^2 = 0.77$) [8]. However, [8] obtained somewhat different results compared to those of our study and determined that there is no statistically significant

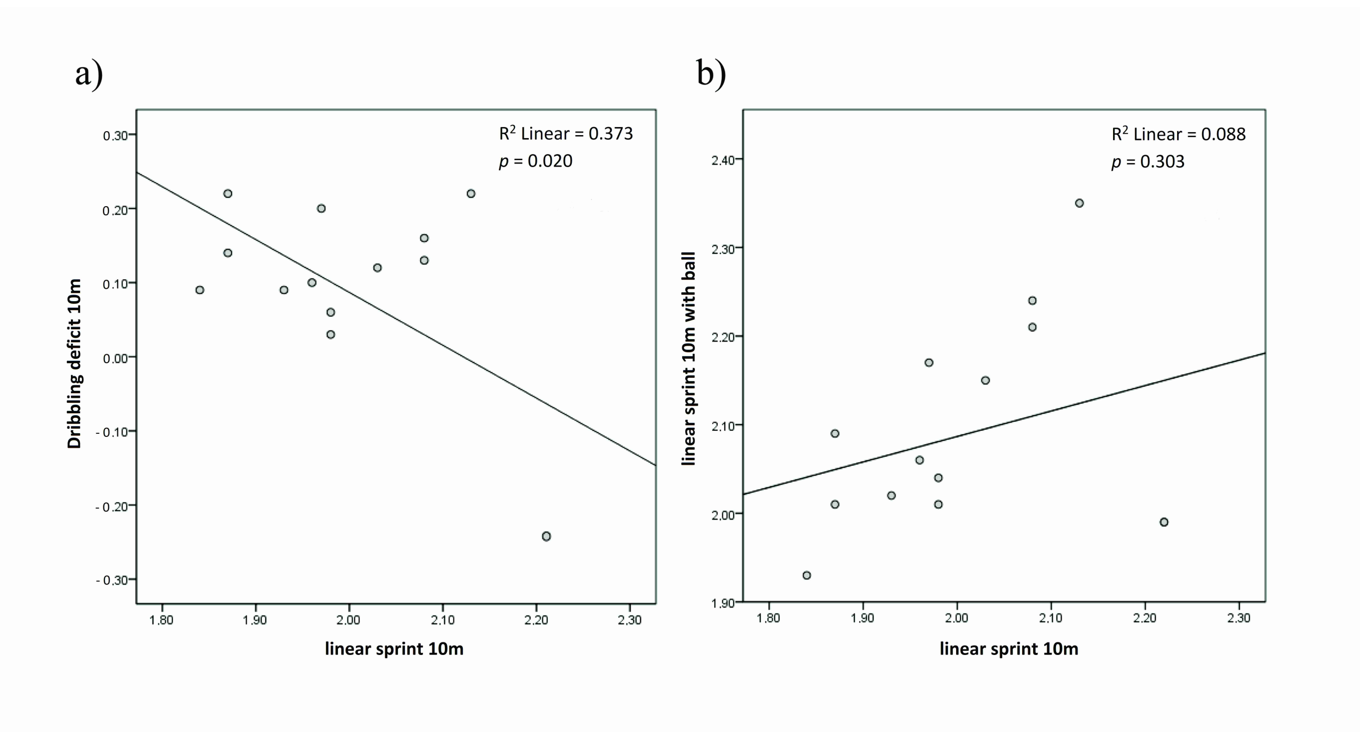

FIGURE 4. Scatterplots showing the connection between the time of the 10 m linear sprint. (a) 10 m Dribble deficit, and (b) the 10 m Dribble among professional handball players.

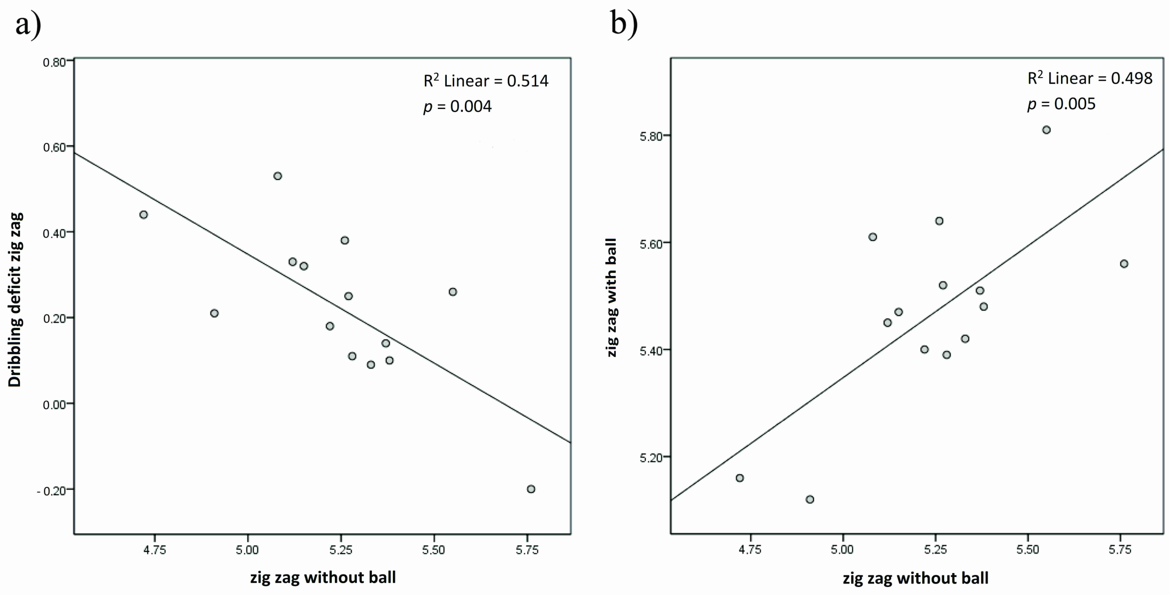

FIGURE 5. Scatterplots indicating the association between the time for the zig-zag with no ball. (a) Dribble deficit zig-zag, and (b) zig-zag with ball.

correlation between the DD and the linear sprint and COD movements among basketball players. What can be noted about the statistically significant results for the DD Test is that there is a reverse, negative correlation for the tests of the linear sprint or COD movement sprint. Due to a lack of studies that investigate DD and technical aspects in basketball players, it is necessary to investigate the influence of physical aspects on dribbling deficit parameters. Even though the total Dribble time can still be used in practice, calculating the DD can provide us with additional useful indicators of technical skills, irrespective of the maximum running speed. The DD is the difference in the results between the time needed to dribble a ball compared to sprint time under the same conditions and for the same previously determined path [8, 15]. Players with a somewhat better overall score in dribbling a ball and a somewhat lower score for the DD can manifest a disturbance between dribbling and the ability to run at maximum speed [9]. These types of tests, which are used to evaluate technique, can also be significant for senior players, where they are used to determine the possible shortcomings that are important for the Dribble technique itself in combination with physical predispositions. In the case of the evaluation of the Dribble, which is under the strong influence of the linear sprint abilities, the player can manifest an improved performance through the improved abilities to increase velocity or speed, where a possible decrease in the ability to technically perform the Dribble can be noted. Contrary to that, with an improvement in linear or COD sprint speed, the DD can remain the same or can potentially worsen if the players are not able to adapt their technical abilities of the Dribble to the improved capacity for linear speed or COD movement [15]. Considering the physical abilities that impact the linear sprint or COD movement sprint, technical abilities indicate a high Dribble ability. Handball is a very complex and multi-factorial sport with specific requirements, and for this reason [23], it is important to recognize a potential interference between the abilities of maximum running speed and Dribbling. Specifically, Ramirez-Campillo *et al.* [9]. The DD was able to negate the impact of the speed of the linear sprint or COD movement sprint and contribute to the speed of the performance technique during Dribble. Dribble is one of the factors that directly impacts the quality of handball players [5]. By developing and overcoming this technique, a significant contribution is made to the game [3, 6], which could later have an impact on the result [5].

Researchers looking at senior handball players and their technique abilities with their non-dominant hand can make limitations and recommendations for future studies. In addition, future research should include more female and male participants. There is not much research about young handball players and their motor abilities, and research like this can improve our knowledge of their development.

5. Conclusions

The results indicate that the linear sprint and zig-zag tests used to evaluate COD movement speed show statistical significant correlation and can impact the DD among professional handball players. Further studies should take into consideration a greater number of research variables, more COD tests like *t* test, Pro Agility, Ilinois agility test or 505 agility test. Also, additional studies need to be conducted among professional handball players, women, or among younger players. Although our results showed the influence of physical performance on DD and do not agree with the results of other authors, the complexity and importance of DD needs to be further research.

AVAILABILITY OF DATA AND MATERIALS

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

AUTHOR CONTRIBUTIONS

SS—Conceptualization, methodology, investigation, formal analysis, writing, visualization, funding acquisition; LP and OR—Methodology, visualization; AL—conceptualization, formal analysis, software; DN and AL—project administration, writing—review and editing, supervision, funding acquisition. All authors have read and agreed to the published version of the manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Participation in the research required the consent of the club's management, expert staff, and the players themselves, which they gave, and the tests were approved by the university's ethics committee. The experiment was performed under the approval of the Ethics Committee of Faculty of Sport and Physical Education, University of Nis, Serbia 04/1092/2.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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