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Research article

THE EFFECT OF DIURNAL VARIATIONS ON CHANGE-OF-DIRECTION AND LINEAR DRIBBLE DEFICIT IN MALE HANDBALL PLAYERS

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Abstract. *The present study aims to determine the effect of time-of-day on linear and change-of-direction Dribble Deficit in elite male handball players. Sixteen elite male handball players from a Serbian Super League club participated in this study (mean ± SD: age 25.4 ± 5.8 years, body mass 94.0 ± 7.4 kg, stature 193.5 ± 7.5 cm). All participants completed four physical performance tests without a ball (change-of direction Zig-Zag test, 5-m, 10-m and 20-m linear sprints) and four tests with a ball (change-of direction Zig-Zag and 5-m, 10-m and 20-m linear sprints) at two separate testing sessions in the morning (8:00-9:30am) and in the evening (6:00-197:30pm). Dribble Deficit parameters for change-of-direction and linear sprint did not differ significantly between the morning and evening sessions (p = 0.309–0.757). To conclude, in elite male handball players, the Dribble Deficit for both change-of-direction and linear sprint tasks remains almost unchanged from early morning to early evening which is important for coaches to organize training sessions.*

Key words: *time of a day, performance, agility, handball, technical skills*

1. INTRODUCTION

Handball is a highly intermittent team-based sport in which players execute frequent accelerations, rapid decelerations, jumps, and repeated throws (Michalsik et al., 2015). Match-play time-motion analyses of elite male players reveal 4,000–5,000 m of total distance covered, including more than 60 high-intensity actions per game, such as different distance sprints and explosive changes of direction (COD) movements (Póvoas et al., 2012). Consequently, the modern handball athlete requires both exceptional linear speed and the ability to cut, pivot, and re-accelerate while controlling the ball under pressure.

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Although straight-line sprinting over 5–20 m underpins fast-break opportunities, decisive one-on-one duels are often won through rapid COD maneuvers executed after one or two steps (Stamenković et al., 2023). In addition, high-speed lateral and diagonal cuts precede ~45 % of goals in professional handball competition, therefore, superior COD proficiency differentiates higher-ranked from lower-ranked teams (Katsumata & Aoki, 2021). Both movement patterns are frequently performed while dribbling, as, for example, back-court and wing players must retain ball control while exploiting space. Accordingly, reliable in-field assessments of linear and COD performance with and without a ball are integral to talent identification and technical performance decisions in high-level handball players.

Traditionally, practitioners have strongly relied on total-time metrics such as the 5-m and 20-m sprint, the 505 or pro-agility shuttle, and Zig-Zag or T-tests conducted with a ball to measure technical performance (Henze et al., 2025). While these protocols show acceptable reliability, their ecological validity is limited by a key confound: total time confounds clear performance capacity with skill execution. More precisely, faster sprinters showed better dribbling times, masking real differences in technical performance (Conte et al., 2020). In addition, movement-path and start-stop mechanics differ across tests, complicating longitudinal comparisons. These limitations have led researchers to look for measures that separate the extra time taken to dribble the ball from pure running speed.

The Dribble Deficit (DD) concept, first introduced in basketball (A. T. Scanlan et al., 2018) and recently adapted for professional handball (Pavlović et al., 2024), addresses this limitation by calculating the additional time incurred when a standardized sprint or COD drill is performed while dribbling. DD compares a player's sprint time with the ball to their sprint time without the ball during the same movement path (A. Scanlan et al., 2018). This method clearly shows dribbling skill instead of pure running speed and has little impact of initial sprint time. Early studies find that DD scores stay very consistent when repeated (ICC ≈ 0.85–0.93) and can clearly distinguish between players of different levels and both genders in handball (Pavlović et al., 2024).

Physical performance is also influenced by circadian rhythms. A recent meta-analysis (Knaier et al., 2022) showed 3–21 % improvements in maximal strength, jump height, and repeated-sprint capacity from morning to late afternoon. In addition to that, handball-specific studies reported evening advantages of ~5–19 % for throwing velocity, grip strength, and COD speed (Pavlović et al., 2018). However, it is still unclear whether time-of-day changes also influence Dribble Deficit, which relies more on ball control than on players' physical performance.

Therefore, the present study aimed to determine the effect of time-of-day on linear and change-of-direction Dribble Deficit in elite male handball players. We hypothesized that DD values would remain relatively stable across the day, reflecting the motor-skill dominance of the measure.

2. METHODS

2.1. Participants

Sixteen elite male handball players from a Serbian Super League club participated in this study (mean ± SD: age 25.4 ± 5.8 years, body mass 94.0 ± 7.4 kg, stature 193.5 ± 7.5 cm). Each player possessed a minimum of five seasons of professional experience and had

completed four weeks of baseline conditioning in the general preparatory phase, ensuring comparable recent training backgrounds. All participants were informed of the study aims and gave informed written consent to participate prior to testing. The study was conducted according to the Declaration of Helsinki and the protocol was fully approved by the Ethics Committee of the Faculty of Sport and Physical Education before commencement.

2.2. Procedure

The testing procedure took place one week before the competitive season commenced. Before each assessment, players carried out a standardized warm-up comprising 8 minutes of moderate jogging, 5 minutes of static stretching, and 2 minutes of short, high-intensity runs. All participants completed four physical performance tests without a ball (change-of direction Zig-Zag test, 5-m, 10-m and 20-m linear sprints) and four tests with a ball (change-of direction Zig-Zag and 5-m, 10-m and 20-m linear sprints) at two separate testing sessions in the morning (8:00-9:30am) and in the evening (6:00-7:30pm).

Change-of-direction Zig-Zag test (with and without a ball)

Closed-skill agility, with and without ball control, was measured using the change-of direction Zig-Zag protocol described by (Sekulic et al., 2013). The course comprised four consecutive 5 m segments connected by 100° changes of direction, and athletes aimed to cover the distance in the shortest possible time. Photocell timing gates (Witty, Microgate, Bolzano, Italy) were mounted 1 m above the ground to record performance. Players began each trial 20 cm behind the first beam to avoid premature activation. First, players completed a trial without the ball, then completed it once while dribbling, where athletes tapped the ball forward with their first stride and maintained control for the whole sprint.

Linear sprint over 5-m, 10-m, and 20-m (with and without a ball)

Sprint speed was assessed over a 20 m distance from a standing start. Photocell timing gates (Witty, Microgate, Bolzano, Italy) set 1 m above the ground were placed at 0, 5, 10, and 20 m, enabling split-time collection. Players began each run 20 cm behind the first beam to avoid premature activation and completed three maximal efforts, each separated by 2 min of passive rest. Split times at 5 m, 10 m, and 20 m were recorded for every attempt. The entire protocol was carried out twice: once without a ball and once while dribbling, where athletes tapped the ball forward with their first stride and maintained control for the whole sprint.

Dribble Deficit

The Zig-Zag Dribble Deficit and linear Dribble Deficit were calculated by subtracting the time difference between the best change-of-direction and linear sprint trial without a ball and the best change-of-direction and linear sprint trial while dribbling for the Zig-Zag and linear sprint over 5-m, 10-m, and 20-m (A. T. Scanlan et al., 2018).

Statistical analysis

Data analysis was performed using the Statistical Package for the Social Sciences (v13.0, SPSS Inc., Chicago, IL, USA). Means and standard deviations (SD) were calculated

for each variable. Differences between morning and evening Dribble Deficit were calculated using a T-test. Statistical significance was set at $p<0.05$.

3. RESULTS

Dribble Deficit parameters for COD and linear sprint did not differ significantly between the morning (08:00–09:30am) and evening (6:00–7:30pm) sessions ($p = 0.309–0.757$). Handball players showed a numerically smaller deficit in the evening (0.300 ± 0.284 s) than in the morning (0.434 ± 0.302 s), suggesting marginally better ball control relative to cutting speed later in the day. For the 5-, 10-, and 20-m sprint time, mean Dribble Deficits were slightly larger in the evening (0.028 ± 0.086 s, 0.098 ± 0.092 s, and 0.178 ± 0.147 s, respectively) than in the morning (0.006 ± 0.077 s, 0.029 ± 0.102 s, and 0.149 ± 0.205 s; Table 1).

Table 1 Dribble Deficit in the morning and evening with statistical comparisons

	Morning		Evening		P-value
	Mean	SD	Mean	SD	
Zig-Zag Dribble Deficit (s)	0.434	0.302	0.300	0.284	.676
5-m sprint Dribble Deficit (s)	0.006	0.077	0.028	0.086	.757
10-m sprint Dribble Deficit (s)	0.029	0.102	0.098	0.092	.309
20-m sprint Dribble Deficit (s)	0.149	0.205	0.178	0.147	.641

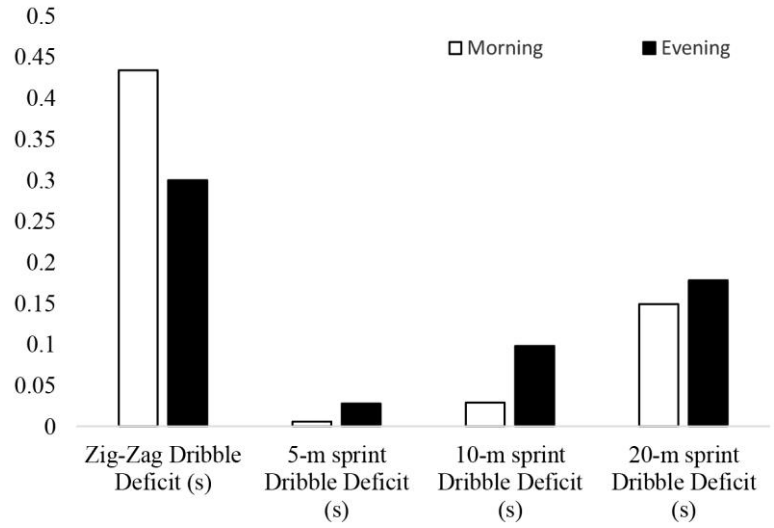

Fig. 1 Morning to evening Dribble Deficit in handball players

4. DISCUSSION

The purpose of this study was to compare change-of-direction and linear sprint Dribble Deficit values between morning and evening in professional handball players. To the best of our knowledge, there are no previous studies that examined diurnal variation in DD, so we compared our findings with studies that used total COD time in other team sports. Our findings indicate that the relative values of dribbling to straight-line or change-of-direction speed are stable, mainly throughout the day, in elite male handball players. Small systematic trends, slightly reduced Dribble Deficit for COD movement in the evening, and marginally higher Dribble Deficit for short linear accelerations, did not overcome inter-individual variability. Practically, this suggests that coaches can schedule skill-speed drills either in the early morning or late afternoon with minimal concern for circadian interference.

Previous research in basketball, futsal, and rugby reported 3–6 % faster COD times in the afternoon compared to the morning and explained that as an effect of higher core temperature and improved neuromuscular activation in the afternoon (Knaier et al., 2022; Martin-López et al., 2024). The absence of a clear time-of-day effect in the present study suggests that the additional deficit of ball handling, rather than initial speed performance, is largely stable over the course of the day. In other words, the neural and thermoregulatory mechanisms that enhance sport performance may not meaningfully alter fine motor control or ball-tracking accuracy when COD movements are performed while dribbling.

Similar findings were observed for the linear-sprint dribble-deficit. Average deficits over 5, 10, and 20 m showed trivial differences between morning and evening test performance. Previous soccer and handball studies have demonstrated 2–4 % faster raw sprints in the late afternoon, but none of them isolated the technical component of dribbling (Pavlović et al., 2018). Our results indicate that the extra time required to maintain ball control during straight-line acceleration does not follow the classic circadian profile observed in previous studies, mainly focused on clear sprint speed. One possible explanation is that dribbling during a sprint depends on maximal stride length and frequency, minimizing the influence of temperature-related changes in muscle contractility. Additionally, hand–ball coordination applied in handball may depend more on visual tracking and proprioceptive feedback, which show smaller day-to-day fluctuations than force production capacity (Hadjisavvas et al., 2024).

Despite the strong benefits of this research as a first study to address the diurnal effect on Dribble Deficit in handball players, there are some limitations. Firstly, the sample consisted of 16 players from a single professional team, limiting result generalization to other competitive levels, females, or youth handball players. Second, chronotype and sleep history were not measured in this study as a very important factor because individual morningness or eveningness preferences could mask or neutral true diurnal effects. Third, only two time points were assessed, providing a basic picture of the circadian rhythm.

5. CONCLUSION

To conclude, in elite male handball players, the dribble-deficit for both change-of-direction and linear sprint tasks remains almost unchanged from early morning to early evening. These data suggest that handball skill in professional players, expressed as the extra time needed to dribble while moving at high speed, is stable across the typical training day, even though running performance may vary. From the practical point of view, coaches can organize

technical drills in both morning and evening sessions without a significant impact on performance decrease or dribble deficit.

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UTICAJ DNEVNIH VARIJACIJA NA DEFICIT U PROMENI PRAVCA KRETANJA I LINEARNOM DRIBLINGU KOD RUKOMETAŠA

Ova studija je utvrđivala uticaj doba dana na pravolinijski sprint i promenu pravca kretanja elitnih rukometaša. Šesnaest elitnih rukometaša koji nastupaju u Superligi Srbije su učestvovali u ovoj studiji (mean ± SD: uzrast 25.4 ± 5.8 godina, telesna masa 94.0 ± 7.4 kg, visina 193.5 ± 7.5 cm). Svi ispitanici su uradili po četiri testa motoričkih sposobnosti s ai bez lopte (promena pravca kretanja zig-zag, 5m, 10m, 20m pravolinijski sprint) u dva vremenska intervala, jutarnji (8:00-9:30 h) i večernji (18:00-19:30 h). Dribling deficit za promenu pravca kretanja i linearni sprint se statistički značajno ne razlikuju prepodne i uveče (p = 0.309–0.757). Kod elitnih rukometaša dribling deficit za promenu pravca kretanja i pravolinijski sprint ostaju nepromenjenji od ranog jutra do večeri što je važno za trenere u organizaciji treninga.

Ključne reči: *doba dana, sposobnosti, agilnost, rukomet, tehničke sposobnosti*