

Occurrence of lower limb asymmetries during deceleration in soccer players in the U19 category

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ABSTRACT

Objective: The main aim of the study was to identify asymmetries between the dominant and non-dominant lower limb during horizontal deceleration in youth soccer players playing at different playing positions. The research sample consisted of players of the Slovak Football Federation academies in the U19 age category (n=228). We tested the horizontal deceleration of the players by 15-0-5 change-of-direction test, which was performed on a 1080 Sprint adjustable motorized resistance device (1080 Motion, Lidingö, Sweden). For statistical analysis, we used descriptive statistics methods, Shapiro-wilk test for normality of data distribution, one-factor ANOVA test, paired t-test, and Cohen's d to determine the effect size. We did not observe statistically significant asymmetries between players at each player position (forwards, wide midfielders, central midfielders, full backs, central defenders) during deceleration for dominant and non-dominant lower limbs. However, we observed the highest level of deceleration in the full backs, also for dominant (mean = $8.30 \text{ m/s}^2 \pm 0.82 \text{ m/s}^2$) and non-dominant (mean = $8.28 \text{ m/s}^2 \pm 0.78 \text{ m/s}^2$) lower limb. We observed the highest level of deceleration in the full backs, who are characterized by the highest number of decelerations in the game, precisely due to the frequent transition between phases of the game. These findings are directly applicable to the design of individual training programs with an emphasis on reducing injury incidence and increasing movement efficiency during deceleration.

KEY WORDS: deceleration, U19, asymmetries, 1080 sprint

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INTRODUCTION

Horizontal acceleration and deceleration are locomotor skills that allow players to change direction and velocity, and are therefore critical in sports such as soccer, which are specific to random intermittent, multi-directional movement (1, 2). Previous studies have extensively addressed the

biomechanical and neuromuscular properties of horizontal acceleration in soccer (3,4,5,6), and as a result, we now know how best to monitor, train, and coach this skill (7,8,9). However, studies addressing the biomechanical and neuromuscular properties of horizontal deceleration are incomparably fewer, by as much as 630% or so (10). Recent

studies have shown that horizontal deceleration aids in manoeuvres occurring during sudden changes of direction in sports such as soccer (11,12). At the same time, data obtained from wearable monitoring devices (GPS) used in matches and training sessions show that high-intensity decelerations ($< -3 \text{ m}\cdot\text{s}^{-2}$) occur more frequently than equally intense accelerations in matches (1). Current data suggest that professional players perform 80-104% more high-intensity decelerations compared to accelerations in a match (13). Other studies have shown that deceleration is an important indicator associated with official match wins in professional football (14,15). In terms of mechanical load, we know that intense deceleration in a match is 41% more demanding than equally intense acceleration and 70% more demanding than other match activities, e.g. running at high speed after initial horizontal deceleration (Dalen et al. 2016). In contrast to acceleration, there is a dominant eccentric action of the muscles (elongation of the muscles to absorb the mechanical load) (16). Given the aforementioned, intense deceleration can

PROBLEM

The topic of deceleration has long been underestimated not only in Slovakia, but also in abroad. We know from research that scientific publications related to deceleration

contribute significantly to muscle damage (17,18) in the case of accumulated neuromuscular fatigue (inadequate control of volume and intensity without adequate recovery) and increase the risk of injury (19,20). Horizontal deceleration is also one of the most common events preceding non-contact ACL (anterior cruciate ligament) injury (21,22,23). The evolution of football in terms of tactics and game models (fast pressing, re-pressing) suggests that the demands on deceleration levels will continue to increase in the future (24,25,26). Deceleration demands in soccer vary considerably across different player positions, reflecting the unique demands placed on players during the game. To illustrate, in a match, players across all playing positions exhibit higher intensity decelerations - stopping speeds (-5.7 to $-6.3 \text{ m}\cdot\text{s}^{-2}$) compared to accelerations (4.4 - $4.7 \text{ m}\cdot\text{s}^{-2}$) (13). Studies show that positions such as full backs and wide midfielders have higher deceleration demands compared to central defenders and central midfielders (27, Baptista et al., 2018, 28). This highlights the variability of decelerations between player functions.

are about 630% less compared to acceleration. This points to the insufficiency and imbalance of scientific research activities focused on deceleration. From the available studies, we know that deceleration

significantly affects a player's performance in a match. At the same time, deceleration is associated with the possible occurrence of

OBJECTIVE

The main objective of this study was to identify asymmetries between the dominant (D-LL) and non-dominant (N-LL) lower limb during horizontal deceleration in youth soccer players. The results were evaluated in the

METHODS

The research sample consisted of players from thirteen Slovak Football Federation (SFZ) academies in the U19 age category ($n = 228$, age = 17.83 ± 1.20 years, weight = 71.93 ± 6.66 kg, height = 180.51 ± 6.16 cm), who were divided according to the player's function: Forwards - F ($n = 39$), Wide midfielders - WM ($n = 49$), Central midfielders - CM ($n = 63$), Full backs - FB ($n = 39$), Central backs - CB ($n = 38$). Testing lasted a total of 7 weeks, with players being tested at their clubs and on different days, but at least 72h after the match (Tuesday, Wednesday, Thursday). Before testing, players performed a complex warm-up according to the RAMP protocol. The testing of the players took place on a standard surface - artificial grass, and the players wore soccer boots, which we tried to bring closer to the conditions of a competitive match. We tested the players' horizontal deceleration performance level by performing a 15-0-5

non-contact injuries, which clearly indicates the importance and relevance of researching it.

context of player functions, which was aimed to approach the specific requirements of deceleration within each player function. We also compared the level of deceleration between player functions.

change-of-direction (COD) test, which was performed on a 1080 Sprint, an adjustable motorized resistance device (333 Hz, 1080 Motion, Lidingö, Sweden). Each player performed 2 trials (D-LL, N-LL). The 1080 Sprint device was 5 m away from the turning point during the 15-0-5 COD test. Starting line was marked with cones from the turning point (15m) and at the same time the line along which the players ran after deceleration (5m). Players were instructed to perform the acceleration phase (15m), deceleration phase and reacceleration phase (5m) of the test as quickly as possible. The assisted load was used run-up towards the 1080 sprint device, followed by a change of direction and a 5m reacceleration - resisted load. The settings of the 1080 sprint device were as follows: Isotonic mode, assisted - resisted load 3kg, assisted - resisted speed (14 m-s⁻¹) (29). This test was part of a comprehensive test battery assessing, in addition to deceleration: running

speed, lower limb explosiveness, hamstring and adductor/abductor strength in different muscle work modes. The selection of the 15-0-5 COD test to determine deceleration levels was supported by a study of Buchheit et al. (29), in which the relevance of this test was addressed. Based on extensive research and feedback from coaches from professional clubs, the relevance of the test was confirmed and key metrics assessing player deceleration were described. This test has also been validated in the context of effectively assessing deceleration in the context of ACL injuries, which are often associated specifically with deceleration. Horizontal deceleration was assessed using a metric expressing the level of deceleration (max deceleration = m/s^{-2}), which describes how fast players are able to decelerate. The metric "max deceleration"- m/s^{-2} , expresses how many meters per second the player decreases his speed every second (example : 8 m/s^{-2} means that the player slows down by 8 meters per second every second). The 15-0-5 test offers a practical way to measure deceleration from high speeds, making it a very valuable

RESULTS

Table 1 shows the level of horizontal deceleration for each player function. For FB, we observed the highest level of horizontal deceleration (D-LL: mean = $8.30 \text{ m/s}^{-2} \pm 0.82 \text{ m/s}^{-2}$; N-LL: mean = $8.28 \text{ m/s}^{-2} \pm 0.78 \text{ m/s}^{-2}$),

tool in detecting asymmetries in injury prevention. Buchheit et al. (30) demonstrated that the 15-0-5 test also reflects the demands on the achieved speed occurring during pressing actions. As a result, we consider the 15-0-5 test to be very comprehensive and suitable for assessing deceleration specific demands of different player functions in soccer.

Data were exported from 1080 motion's cloud (<https://webapp.1080motion.com/>)

individually for each player, and processed in Excel (Microsoft 365 (Office)) to evaluate the basic values of descriptive statistics (mean, SD). With the JASP software, we confirmed the normality of the data distribution with the Shapiro Wilk's test. Paired t-test was used to evaluate statistical significance at a sensitivity level of $p < 0.05$. The effect size was determined by Cohen's d: $0 - 0.19 =$ trivial effect size; $0.20 - 0.49 =$ small effect size; $0.50 - 0.79 =$ medium effect size; 0.80 and above = large effect size (31). Differences between player functions during horizontal deceleration of D-LL and N-LL were evaluated by a one-factor ANOVA analysis of variance.

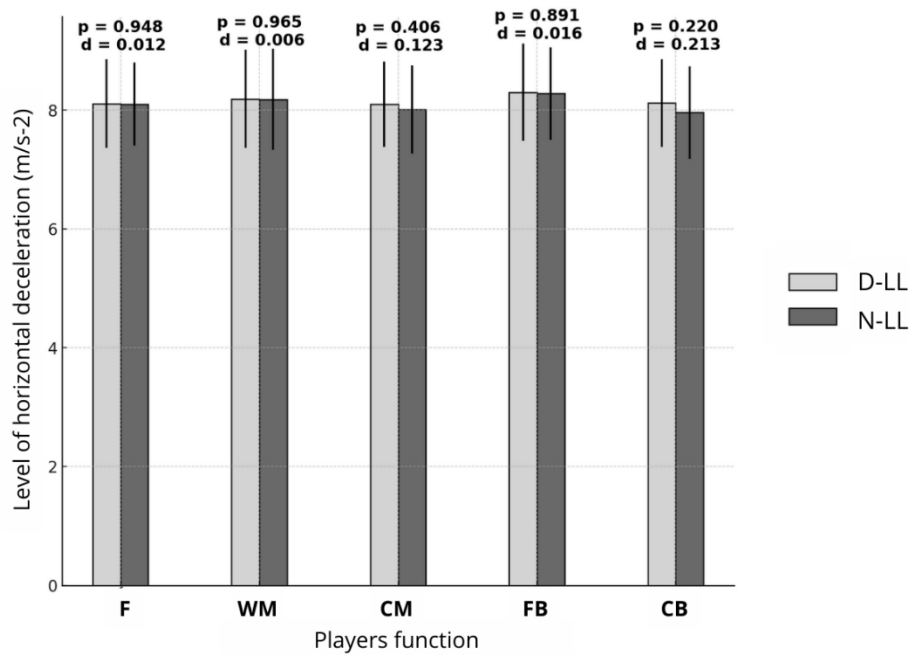
with these players showing moderate inter-individual variability. The occurrence of asymmetries was not statistically significant ($p = 0.891$) and the effect size was trivial ($d = 0.016$). For WM, the second highest level of horizontal deceleration was observed (D-LL:

mean = $8.19 \text{ m/s}^{-2} \pm 0.83 \text{ m/s}^{-2}$; N-LL: mean = $8.18 \text{ m/s}^{-2} \pm 0.85 \text{ m/s}^{-2}$), with slightly higher variability compared to FB. The occurrence of asymmetries was not statistically significant ($p = 0.965$), the effect size was trivial ($d = 0.006$), with this value indicating an almost unnoticeable difference between D-LL and N-LL. Players playing as CD achieved the third highest level of horizontal deceleration (D-LL: mean = $8.12 \text{ m/s}^{-2} \pm 0.74 \text{ m/s}^{-2}$; N-LL: mean = $7.96 \text{ m/s}^{-2} \pm 0.78 \text{ m/s}^{-2}$). At the same time, these players show moderate inter-individual variability, with N-LL having the lowest horizontal deceleration value. Also in this case, the occurrence of asymmetries was not statistically significant ($p = 0.22$), but the effect size was small ($d = 0.213$), which for us

represents the highest level of asymmetries between D-LL and N-LL during horizontal deceleration. F reached the fourth highest level of horizontal deceleration (D-LL mean = $8.11 \text{ m/s}^{-2} \pm 0.75 \text{ m/s}^{-2}$; N-LL: mean = $8.10 \text{ m/s}^{-2} \pm 0.70 \text{ m/s}^{-2}$) with the lowest inter-individual variability. The occurrence of asymmetries was not statistically significant ($p = 0.948$) with a trivial effect size ($d = 0.012$). For CM, we observed the lowest level of horizontal deceleration between players (D-LL: mean = $8.10 \text{ m/s}^{-2} \pm 0.72 \text{ m/s}^{-2}$; N-LL: mean = $8.01 \text{ m/s}^{-2} \pm 0.74 \text{ m/s}^{-2}$), with low inter-individual variability. The occurrence of asymmetries was not statistically significant ($p = 0.406$) and the effect size was trivial ($d = 0.123$).

Table 1 Horizontal deceleration values across player functions

Players function	D-LL (m/s^{-2})		N-LL (m/s^{-2})		p - value	Cohen d
	mean	SD	mean	SD		
FB	8,30	0,82	8,28	0,78	0,891	0,016
WM	8,19	0,83	8,18	0,85	0,965	0,006
CB	8,12	0,74	7,96	0,78	0,220	0,213
F	8,11	0,75	8,10	0,70	0,948	0,012
CM	8,10	0,72	8,01	0,74	0,406	0,123



Graph 1 Occurrence of asymmetries during horizontal deceleration between D-LL (dominant lower limb) and N-LL (dominant lower limb)

Based on a one-factor ANOVA analysis, there was no statistically significant difference confirmed between player functions (D-LL : $F = 0.469$, $p = 0.758$, N-LL : $F = 1.199$, $p = 0.312$).

CONCLUSION

There were no statistically significant asymmetries on all player functions during horizontal deceleration in the 15-0-5 COD test. This indicates to us the balance of the level of horizontal deceleration, during D-LL and N-LL between players, on the observed player functions, as shown in Figure 1. However, it is important to mention the different level of horizontal deceleration not across player functions. Morgans et al. 2025 and Silva et al. (27) point out that FB and WM show the most decelerations activities in the match. From the results of our study, we can say that FB and WM also show the highest level of horizontal deceleration, also in the

case of D-LL and N-LL (FB : D-LL: mean = 8.30 m/s⁻²; N-LL: mean = 8.28 m/s⁻²; WM : D-LL: mean = 8.19 m/s⁻²; N-LL: mean = 8.18 m/s⁻²). For these players, this represents a huge amount of accumulated neuromuscular fatigue exposed during the match when decelerating. Such loads also require adequate specific strength and coordination training (eccentric strength training, specific deceleration training)(25, Jones et al. 2017). Harper et al. (10) made very detailed practical recommendations framework in one of their recent studies. By applying these recommendations, which consist of excentric training variation with combination of specific deceleration drills, players will be more

effective and especially, more resilient to neuromuscular fatigue and also potential non-contact injuries occurring during deceleration. The frequency of deceleration and other high-intensity activities in a match should be seen in a broader context. Variables such as accumulated player fatigue, table standings, overall match progression, game formation, and tactics are also influential (Morgans et al., 2025, 32). Therefore, Harper et al. (10) emphasize that deceleration training should also be in the context of individual game situations and player functions. This is particularly relevant to defensive activities, which requires a high level of reaction ability to opponent movement. These activities are associated with higher risk of non-contact injuries during deceleration - ACL injuries, hamstring injuries (21)

LIMITATIONS OF THE STUDY

We perceive several limitations within our study that could have potentially affected the conclusions based on the statistical analysis. One of these is the unequal number of players representing each player function. CM had the highest number of players ($n = 63$) and CB had the lowest number of players ($n = 38$), which is 40.7% fewer CB than CM. This may have influenced the variability in the analysis of asymmetries between D-LL and N-LL, as well as the analysis of differences between player functions. Another limitation may be the lack

of players' acceleration (to 15 m) during the 15-0-5 direction changes test. For players who did not put out maximum effort as instructed, the resulting level of horizontal deceleration may be lower. For this reason, it would be useful to determine the level of speed that players need to achieve during the 15m run-up phase of the 15-0-5 COD test. In particular, this would be 90% of the speed achieved during the 15m linear sprint. Based on this, we would only evaluate players who have achieved a high rate of acceleration (15m) before deceleration.

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