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Does monopodal postural balance differ between the dominant leg and the non-dominant leg? A review

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Abstract

The interlimb postural comparison i.e., between the dominant leg and the non-dominant leg has been studied by numerous authors but their results are contradictory and do not lead to a consensus. Some studies showed no difference of postural balance between the dominant and the non-dominant leg whereas other studies concluded that the dominant and non-dominant leg exhibit different postural balance in healthy subjects and athletes. The aim was to analyse all these studies in order to identify the different factors that could facilitate or prevent the appearance of a postural difference between the dominant and non-dominant leg by means of a narrative review. Environmental and experimental conditions (e.g., difficulty and specificity of postural tasks; physiological state, expertise level and moment of season/period over career of subjects/athletes evaluated and nature of sport/physical activity practiced; techniques and methods used for measuring postural balance) in which postural balance is evaluated and intrinsic/individual factors (e.g., morphology, strength/power muscle, proprioception, hemispheric laterality) could influence the results. Thus, the influence of limb dominance on monopodal postural balance would probably be context-dependent. Mechanistic explanations are proposed to explain how each factor could act on the relationship between limb dominance and postural balance. However many mechanisms have not yet been explained and all the factors have not been identified, which suggests that further exploratory research is needed in order to understand this relationship.

Key Words Balance; Posture; Postural control; Postural balance; Physical activity; Sport; Dominant leg; Non-Dominant leg

1. Introduction

Motor experience generates structural and functional adaptations of the postural function (Paillard, 2017a). However, the postural adaptations linked to regularly repeated motor tasks are specific to the context in which they are carried out (Paillard, 2014). The repetition of decontextualized balance motor tasks aimed at improving postural balance would, in general, be of little interest since it would engender no, or only a very slight, transfer to non-trained balance motor tasks (Paillard, 2017a). In fact, the improvement of postural balance is based more on the sum of specifically learned skills than on a general development of postural balance which can be enhanced irrespective of the balance motor tasks that were trained in the past (Kümmel et al., 2016). Specific motor tasks involving particular postures and a single environmental condition develop specific postural skills (Paillard, 2014). Hence, the postural adaptations are so specific to motor experience that one can question if there is any difference between the **two legs** in terms of postural balance since they often perform different motor tasks. For example, one leg achieves a motor skill while the other supports body mass. This is worth being analyzed because a significant postural difference between the two legs is likely to negatively affect motor performance (e.g., power, agility) and sports performance (e.g., sprinting, swimming, basketball, rowing), which might increase the risk of injury (lower-extremity injury), and provoke falls in sport and frail/older individuals (Bishop et al., 2018; Brown et al., 2018; Laroche et al., 2012).

The interlimb analysis is carried out by comparing the postural balance of the dominant leg (the dominant leg is classically defined by asking an individual to kick a ball) with that of the non-dominant leg (Figure 1). Other means can be also employed to define the dominant leg on the basis of strength tests (e.g., single leg jumping), functional tests (stepping up, hopping, picking up, regaining balance after postural perturbation) and footedness questionnaires (participant's self-reporting leg preference) (Huurnink et al., 2014; Muehlbauer et al., 2014;

Hoffman et al., 1998). Caution is required when differentiating the dominant and non-dominant leg since few authors define the dominant leg as the stance limb initially selected when standing on one leg (e.g. Beretta et al., 2015). The dominant leg (also named the preference leg), which is mainly used to perform movement or motor tasks requiring force and/or accuracy (e.g., stepping up, hopping, ball kicking, and picking up), should not be confused with the non-dominant leg (stance leg), which supports the body (Wang and Newell, 2013; Huurnink et al., 2014). In this context, the ball kick test is a simple and reliable test which avoids this confusion, thus explaining why it has been used in the vast majority of research studies about limb dominance in postural balance (e.,g., Schneiders et al., 2010).

The interlimb postural comparison (i.e., dominant leg versus non-dominant leg) has been studied by numerous authors but their results differ and do not lead to a consensus in healthy adult subjects (Paillard, 2017a). Based on monopodal postural differences between the dominant leg and the non-dominant leg, it is possible that several factors differently affect the monopodal postural balance of each leg, either accentuating or reducing these differences irrespective of any pathology (e.g., Parkinson's disease and anterior cruciate ligament injury provoke postural asymmetries between the two legs -Beretta et al., 2015; Mohammadi et al., 2012). These factors could be related to a number individual and environmental characteristics. However, they remain to be identified on the basis of plausible mechanistic explanations.

Hence, a better knowledge of the impact of leg dominance on the monopodal postural balance could help sports trainers to optimize motor performance and to prevent injuries among athletes, and could help physicians to improve the effects of their therapeutic programs and their preventive measures against falls for frail or older subjects. Therefore, the present work aims to identify the factors that are likely to accentuate or reduce the effects of leg dominance on monopodal postural balance by developing new insights about their impact.

2. Methodology

An exhaustive search for articles dealing with the influence of leg dominance on the monopodal postural balance was carried out on the basis of keywords ("Postural balance", "Posture", "Monopodal stance", "Leg dominance", "Leg preference", "Inter-limb asymmetry", "Laterality", "Footedness") using the electronic databases PubMed, ScienceDirect and Google Scholar. The difficulty of analyzing and quantifying the highly divergent results related to the complexity and wide variety of experimental protocols (the lack of standardization of protocols) led us to carry out a descriptive and theoretical analysis (i.e., a narrative review) of the studies available in the scientific literature.

3. Postural comparison between the dominant leg and the non-dominant leg

Most studies which have compared the monopodal postural balance of the dominant and the non-dominant leg were cross-sectional (see tables 1 and 2) and only very few experimental protocols were based on intervention studies (e.g., Slomka et al., 2018; Karakaya et al., 2015). Hence, the evaluation of the effects of motor experience (sports training or physical activity regularly practiced) on the monopodal postural balance comparing the dominant leg and the non-dominant leg could be insufficiently discriminating if not supplemented with an evaluation of the environmental and experimental conditions (e.g., Promsri et al., 2020, 2019).

3.1. Is there any tangible postural difference between the dominant and non-dominant leg?

Certain studies showed no difference in terms of postural balance between the dominant and the non-dominant leg in athletes (basketball, field hockey, futsal and soccer players, gymnasts, swimmers) and healthy active or sedentary adults (Hoffman et al., 1998; Bressel et al., 2007; Thorpe and Ebersole, 2008; Matsuda et al., 2008; Lin et al., 2009; Gstöttner et al., 2009; Sabin et al., 2010; Matsuda et al., 2010a; Matsuda et al., 2010b; Alonso et al., 2011;

Teixeira et al., 2011; Overmoyer and Reiser, 2013; Muehlbauer et al., 2014; Huurnink et al., 2014; Pau et al., 2014; Cug et al. 2014; Karakaya et al., 2015; Kim and Yoo, 2015; Cug et al., 2016b; Debski et al., 2017; Mala et al., 2017; Muehlbauer et al., 2019; Lopez-Fernandez et al., 2020), whereas other studies concluded that the dominant and non-dominant leg exhibited different postural balance in athletes (dancers, skiers and basketball, handball, rugby, soccer, tennis, and volleyball players) and in healthy active or sedentary adults (Clifford and Holder-Powell, 2010; Ricotti and Ravaschio, 2011; Barone et al., 2011; Brito et al., 2012; Lin et al., 2013; Ricotti et al., 2013; Kartal, 2014; Vieira et al., 2014; Marchetti et al., 2014; Kiyota and Fujiwara, 2014; Kovacikova et al., 2015; Fort-Vanmeerhaeghe et al., 2015; Dabadghav et al., 2016; Miller et al., 2017; Brown et al., 2018; Jadczyk et al., 2019; Promsri et al., 2019). These different results could stem from a multitude of factors that could be identified on the basis of the available data in the literature and also through theoretical considerations likely to enhance understanding of the topic tackled.

3.2. Influencing factors related to environmental and experimental conditions

Most studies that showed no difference between the two legs were carried out predominantly with populations who did not exhibit marked differences in terms of motor tasks between the two legs (no leg executed highly specialized motor tasks in comparison to the other leg), i.e. in sedentary subjects, students, undergraduate and graduate students studying exercise and health sciences (Hoffman et al., 1998; Alonso et al., 2011; Karakaya et al., 2015). When the population does show differences between the two legs in terms of respective motor tasks during sport practice one can often (but not always) observe postural differences between the dominant and the non-dominant leg (Paillard, 2017a).

According to the sport practised and the specificity of postures involved, the leg showing better postural performance can be either the dominant leg or the non-dominant leg. For example, soccer requires a monopodal posture to perform different technical movements (e.g.

shooting, passing) with the dominant leg, while the stability of the supporting leg, i.e. the non-dominant leg, turns out to be essential in order to shoot as accurately as possible (Paillard et al., 2006). While reporting that the non-dominant leg balance was more highly correlated than the dominant leg balance with the dominant leg kicking accuracy in soccer players, Chew-Bullock et al. (2012) stated that monopodal postural balance on the non-dominant leg could predict kicking performance on the dominant leg. The regular practice of soccer or other asymmetric sports such as volleyball, handball, and tennis would induce specific postural adaptations which could explain why the non-dominant leg showed better postural balance than the dominant leg (Ricotti and Ravaschio, 2011; Barone et al., 2011; Ricotti et al., 2013; Kartal, 2014; Marchetti et al., 2014). By contrast, ballet dancers, who spend more time training on the right leg (the dominant leg for most of the subjects), because of the normal instructional methods of ballet training, develop better postural performance on the dominant leg than on the non-dominant leg (Lin et al., 2013). The possible influence of the leg dominance on the monopodal postural balance (if it exists) could be sport-dependent - i.e. induced posture-dependent.

The expertise level of subjects (athletes) is also likely to accentuate the difference between the dominant leg and the non-dominant leg (Kilroy et al., 2016; Lin et al., 2013; Brito et al., 2012) especially when they are evaluated in postural conditions close to those encountered in sports practice i.e., in dynamic condition (Jadczak et al., 2019; Ricotti et al., 2013). For example, professional soccer players and expert dancers exhibited differences between their two legs, whereas non-professional soccer players and novice dancers did not show any difference (Ricotti et al., 2013; Lin et al., 2013; Kilroy et al., 2016). Indeed, a high level of motor skills associated with a high level of training (i.e. the number of hours of training per week) could contribute to a high specialization of athletes' motor skills and to a differentiation of motor or postural skills between each leg (Paillard, 2017a). However, Debski et al. (2017)

and Pau et al. (2014) did not report any postural difference between the dominant leg and non-dominant leg in professional soccer players. This means either that the expertise level does not constitute a determining factor or the difference between the two legs remains relatively subtle and involves other factors.

Since training generates postural adaptations, it was suggested that, logically, the greatest amount of training (activity volume) engenders the greatest and most specialized postural adaptations (Paillard, 2017a). If the hypothesis is that the postural difference between the dominant leg and the non-dominant leg occurs under specialized training conditions, it could be deduced that this postural difference would increase progressively and simultaneously with motor experience in athletes. One can therefore postulate that postural asymmetry between the dominant leg and the non-dominant leg would appear or increase as the sport season progresses. This postulate was emphasized by Marchetti et al. (2014) and Ricotti and Ravaschio (2011) who observed that a longitudinal follow-up throughout a sport season refines the observation of measures in handball and soccer athletes respectively. However, the acquisition or learning of motor skills through training in the dominant leg could be also transferred to the non-dominant leg which would limit possible postural differences between the two legs. Unilateral training with a large motor learning component, particularly as part of complex or novel motor tasks, would seem to favor the acquisition by the dominant limb and the transfer to the non-dominant limb (Farthing et al., 2009). These authors asserted that optimal information regarding the goals of the movement and precise patterns of muscle activation can be transferred to the non-dominant limb to enhance motor planning and motor command through the phenomenon of cross-education. Hence, after training of the dominant limb, the two limbs are virtually equivalent at the motor planning level (Farthing et al., 2009). An initial postural asymmetry between the dominant and non-dominant leg could even be reduced after training programs (e.g., jumps, balance exercises) in young soccer players and

skiers (Pardos-Mainer et al., 2019; Slomka et al., 2018). Learning in the trained limb would engender cortical adaptations which would improve the pattern of muscle activation in the untrained limb (e.g., coordination of agonists and antagonists, synergist muscle activity related to postural balance) (Frazer et al., 2018). This model suggests that unilateral training leads to cortical adaptations that are shared by both limbs and that optimal information for producing motor performance is stored when the more proficient limb (i.e., the dominant or the non-dominant leg) is used for training (Farthing et al., 2009). In this context, postural balance would be similar between the dominant and the non-dominant leg.

It is known that fatigue disturbs postural balance and implies an increased contribution of cognitive resources and/or provokes the triggering of different motor strategies to limit or compensate the degrading effects on postural control (Paillard, 2012). From a strictly motor point of view (motor function), it was reported that there were different impairments in isometric force between the musculature of the dominant leg and that of the non-dominant leg during early recovery from fatiguing tasks in active males (Willems and Ponte, 2013). Hence, in a state of fatigue, there would be two possible scenarios for active subjects/athletes. The first being that, if there is any postural difference between the dominant leg and the non-dominant leg, it would be amplified by fatigue. The second being that if there is initially no postural difference between the two legs, it could appear only in a state of fatigue (Kim and Yoo, 2015). Therefore, fatiguing tasks could be undertaken to distinguish more accurately the possible differences between the dominant and the non-dominant leg. Studies about the effects of fatigue induced by general exercises such as treadmill running, a Wingate anaerobic test, one half of a soccer match or a netball game match, as well as local exercise such as a knee-extension exercise (leg press), have shown that fatigue could accentuate the difference in terms postural balance between the two legs in soccer, basketball, and netball players and

healthy sedentary young subjects (Waterman et al., 2004; Erkmen et al., 2012; Yamada et al., 2012).

Moreover, the absence of difference between the two legs observed by some authors could also result from the nature of the monopodal postural tests completed. Static (Hoffman et al., 1998; Huurnink et al., 2014; Muehlbauer et al., 2014; Karakaya et al., 2015) or dynamic (Bressel et al., 2007; Thorpe and Ebersole, 2008; Sabin et al., 2010; Cug et al., 2016a) balance tests have been used but these tests were different from the specific postural conditions related to the motor experience of the participants. Only a few studies tested dynamic balance tasks which were close to the specific conditions through surface tilt or repetitive hip flexion-extension and adduction-abduction movements of the swing leg (Gstöttner et al., 2009; Teixeira et al., 2011). Gstöttner et al. (2009) reported a tendency toward better balance in the non-dominant leg than in the dominant leg, whereas Teixeira et al. (2011) did not observe any difference between the two legs. Gstöttner et al. (2009) suggested that the postural difference between the dominant and non-dominant leg could be more obvious in a test that is more difficult/demanding for the locomotor system. In any case, potential postural differences between the dominant and non-dominant leg would be more likely to occur in dynamic than in static conditions (King and Wang, 2017; Promsri et al., 2018) especially in athletes who practice a dynamic sport such as soccer (Jadczak et al., 2019). When no distinction can be made between the dominant leg and the non-dominant leg through classic analyses of spatio-temporal parameters of centre of foot pressure displacements, one could refine the methods of analysis in order to observe this possible distinction. A greater subtlety in the measure of balance through frequency analysis of the displacement of centre of foot of pressure, time analysis of postural re-stabilization after postural perturbation and biomechanical analysis of segmental organization can contribute to refining the differences in postural balance between

the dominant and the non-dominant leg (Clifford and Holder-Powell, 2010; Kiyota and Fujiwara, 2014; Kovacikova et al., 2015; Promsri et al., 2018, 2020).

On the basis of data mentioned above, it can be suggested that many environmental and experimental parameters (e.g., techniques and methods used for measuring postural balance, difficulty and specificity of postural tasks, physiological state, expertise level and moment of season/period over career of subjects/athletes evaluated, nature of sport/physical activity practiced -i.e. symmetric or asymmetric technical movements-, specificity of posture/position involved in physical practice -i.e., motor skills performed on mono or bipedal stance) are likely to influence the relationship between the dominant leg and the non-dominant leg in terms postural balance. Moreover, intrinsic factors could also influence this relationship between the dominant and the non-dominant leg in terms of monopodal postural balance.

3.3. Intrinsic influencing factors

It has been shown that the dominant leg and the non-dominant leg can exhibit differences in terms of morphology, musculo-tendinous mechanical properties, muscle strength/power, joint mobility, and sensorimotor function (Ludwig et al., 2017; Bishop et al., 2018; Lin et al., 2013; Lanshammar and Ribom, 2011). Since the biological and physiological characteristics mentioned above are likely to impact postural balance in healthy and pathological subjects (Paillard, 2017a; Paillard, 2017b; Chung et al., 2008), one can hypothesize that they differently influence the monopodal postural balance of the dominant and the non-dominant leg.

From a morphological viewpoint, Ludwig et al. (2017) showed that the dominant leg presented a larger knee valgus angle than the non-dominant leg, which could produce differences in terms of postural attitude (static leg axes) and thus postural balance between the two legs. Muscle mass can also differ between the dominant and the non-dominant leg which

logically entails differences in the subjects' motor function (i.e., a component of postural function) between each leg (Bishop et al., 2018). Even without bilateral asymmetry in muscle mass, muscle contractility can differ between the dominant and the non-dominant leg in sub-elite futsal players (Lopez-Fernandez et al., 2020). Achilles tendon mechanical properties can also differ between the dominant and the non-dominant leg in physically active healthy adults who practiced no asymmetrical activity in terms of leg workload (Bohm et al., 2015). From a muscle strength/power viewpoint, it was observed that ground reaction forces were higher for the non-dominant leg than for the dominant leg in young and adult athletes (Bishop et al., 2018; Atkins et al., 2016) which could cause differences between the monopodal postural balance of the dominant leg and that of the non-dominant leg (Bishop et al., 2018; Kilroy et al., 2016) since muscle strength/power can affect postural balance (Paillard, 2017b). From the viewpoint of segmental or joint mobility, Lin et al. (2013) reported that the dominant leg and the non-dominant leg exhibit different amplitudes during the execution of pirouettes in dancers. These authors suggested that this difference of joint mobility could affect the monopodal postural balance of the two legs. From a sensorimotor viewpoint, it was reported that as part of an asymmetrical motricity related to motor and postural tasks, the volume of physical load on monopodal stance (i.e., one-leg standing) differ between the dominant leg and the non-dominant (Mala et al., 2017) which can generate differences in terms of proprioception between the two legs since the motor experience/sports training refines proprioception (Paillard, 2017a). Knowing that proprioception influences postural balance, the difference of proprioception between the dominant leg and the non-dominant leg would be likely to affect their postural balance differently. Other sensorimotor functions (in particular visual and vestibular) would be also likely to generate inter-limb asymmetries with regard to the monopodal postural balance. Visual dominance (the directing eye i.e., hemispheric visual asymmetry) as well as lateral vestibular preference (i.e., vestibulo-cortical hemispheric

lateralization) would be likely to influence the monopedal postural balance between the two legs (Previc, 1991; Golomer and Mbongo, 2004).

Moreover, as part of the study of the postural relationship between the dominant and the non-dominant leg, it seems useful to integrate data about motor command (central command, i.e., neurophysiological considerations) between the two legs. As part of the activities of daily living, the least of motor actions is always (or most of the time) performed with the dominant limb which can be considered as a lateral motor specificity (Steinbach, 1964). Cantrell et al. (2020) reported a significant negative correlation between an asymmetry score of the H-reflex (soleus Hoffmann reflex ratio between the two legs) and postural balance in healthy and pathological subjects. Their results suggest that at the spinal level, an asymmetry in motor neuron excitability between the two legs is likely to impact monopedal postural balance. At the cerebral level, this motor specificity can also be characterized by the fact that the lower limb laterality is associated with different activation characteristics in the primary motor cortex and the basal ganglia (Kapreli et al., 2006). During the preparatory process of a motor action with the non-dominant hand, the excitability increased in the non-dominant hemisphere and decreased in the dominant hemisphere while with the dominant hand, the only change was a decrease in the non-dominant hemisphere (Poole et al., 2018). In fact, the upper limb dominance is often attributed to cerebral hemispheric asymmetry (Promsri et al., 2018). Each hemisphere/limb is specialized for different functions, i.e., the dominant limb for controlling trajectory dynamics and the non-dominant limb for controlling limb positioning. According to Promsri et al. (2018), it is highly plausible that cerebral hemispheric asymmetry causes process differences in the control of movements not only in the upper limb but also in the lower limb and that such differences should be detectable. **These authors examined the control of kinematic movement synergies in one-leg balancing and suggested different control characteristics between dominant and non-dominant leg. The effect of limb dominance was not**

uniform, but synergy-dependent - an observation that agrees with predictions from motor control theories and that relates to the task-specificity of balancing skills.

The finding above suggest that postural regulation could be based on a lateralized hemispheric brain function (Cioncoloni et al., 2016). These authors inferred that the functional asymmetry between the two homologous primary motor areas would imply that the dominant hemisphere plays a critical role in the selection of the appropriate postural strategy. The fact that stroke damage to the right as compared to the left cerebral hemisphere leads to poorer postural responses both in quiet and perturbed balance would reinforce this assumption and would suggest that the right cerebral hemisphere plays a more prominent role in efferent process responsible for postural balance (Fernandes et al., 2018). These authors proposed that cerebral hemisphere specialization should not be understood as an absolute dominance of the right over the left cerebral hemisphere for balance control, but as a functional superiority of the right hemisphere at processing functions relevant for balance control leading to its greater proportional influence on stabilization and recovery of upright balance. This is why the dominant foot would affect the postural balance mechanism (Yoshida et al., 2014).

4. Conclusion

A thorough examination of the current literature does not allow one to conclude whether limb dominance does or does not influence the monopedal postural balance. Indeed, the studies published to date have shown that the dominant leg and the non-dominant leg can display different postural balance but they can also exhibit similar postural balance. In fact, there are multiple factors that could induce postural difference between the two legs but also there are multiple factors that could prevent any appearance of postural difference. The overall picture shows that factors can counteract in certain contexts which induce no postural difference while postural differences arise in other contexts in the presence of additional factors that

generates postural difference. Thus, the influence of limb dominance on the monopodal postural balance would be context-dependent. The combined presence of certain factors is likely to accentuate or reduce the effects of leg dominance on the monopodal postural balance. A single factor is probably not enough to impact postural balance of the two legs significantly and differently. For instance, fatigue should be associated at least with another environmental or experimental favorable condition (e.g., expertise, asymmetric activity, specific postural test) to generate postural difference between the dominant leg and the non-dominant leg. In order to advance our knowledge of the influence of limb dominance on the monopodal postural balance, the different contexts under which they are studied (e.g., symmetric versus asymmetric physical activity, specific versus not specific postural test, expert versus not expert subjects, fatigue versus non-fatigue state, basic versus subtle/elaborated analysis technique and method; high versus low training -or physical load- level; extensive versus little experience) should be identified and specifically tested in future research. At last, intrinsic factors of subjects should not be obscured in next experimental protocols since their impact is likely to be significant.

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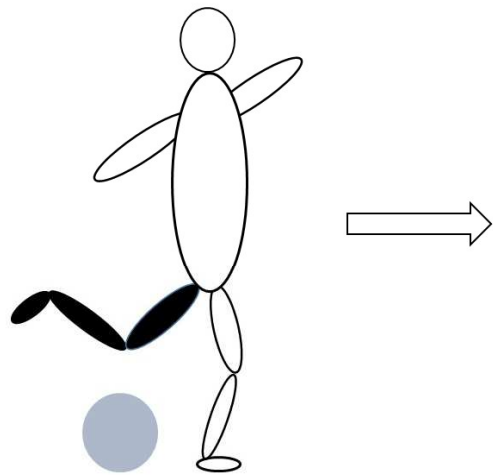
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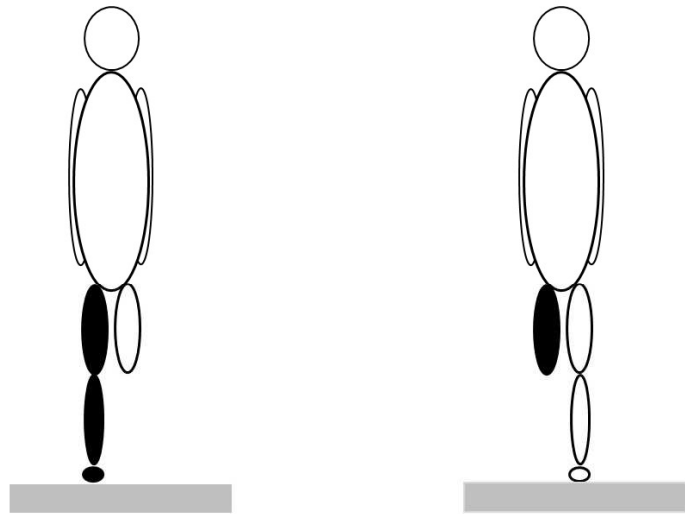
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A - Identification of the dominant leg



The dominant leg is classically defined by asking an individual to kick a ball (grey circle)

B – Evaluation of the monopedal postural balance



Evaluation of the monopedal postural balance of the dominant leg (black color) and the non-dominant leg (white color) on a force platform (grey rectangle)

Figure 1 : (A) Illustration of the identification of the dominant leg i.e., the black leg and (B) illustration of the monopedal postural tests on the dominant leg and non-dominant leg.

	Evaluation technique and measured parameters	Test duration	Definition of the dominant leg	Number and types of subjects	Comparison NDL/DL
Mala et al. (2017)	Force platform; COP length	30 s in static condition	Preferred leg for kicking a ball	64 elite soccer players - 24 seniors - 20 U-21 - 16 (or 20 ?) U-16	NDL = DL
Debski et al. (2017)	Balance SD System; stability index scores	20 s in dynamic (least stable i.e., level 1) condition	Preferred leg for kicking a ball	27 (or 31?) soccer players evolving from the I-IV leagues	NDL = DL
Pau et al. (2014)	Pressure platform; COP surface area, length, amplitude and velocity	20 s in static condition	Preferred leg for kicking a ball	71 soccer players - 19 professional (serie A) - 17 U-19 - 20 U-17 - 15 U-15	NDL = DL
Huurnink et al. (2014)	Force platform; COP velocity and Motion analysis, 3-dimension trajectories of markers; angular velocity of the ankle and hip	20 s in static condition (as well as 5 motor tasks such as step-up, hop, ball kick, dynamic balance during 10 s, pick-up)	Preferred leg for stepping up, hopping, kicking a ball, balancing and picking up	16 field hockey athletes (inter-district or national level)	NDL = DL
Muehlbauer et al. (2014)	Force platform; COP surface area and COP length	30 s in static condition (eyes open or closed, firm or foam ground)	Defined through 4 questions: ball kick, pick-up, step-up on a bug, step-up onto a chair	30 healthy young adults	NDL = DL
Cug et al (2014)	Balance SD System; stability index scores	20 s in dynamic (least stable i.e., level 1) condition	Preferred leg for kicking a ball	45 healthy no active (for 6 months prior the protocol) subjects	NDL = DL
Teixeira et al. (2011)	Force platform; COP surface area	6 s in static and dynamic condition	Preferred leg for kicking a ball	- 11 experienced male soccer players - 11 non-soccer players	NDL = DL
Alonso et al. (2011)	Balance SD System; stability index scores	20 s in static (more stable i.e., level 8) and dynamic (less stable i.e., level 2) conditions	Preferred leg for kicking a ball	40 healthy sedentary males (between 20 and 40 years old)	NDL = DL
Matsuda et al. (2010b)	Force platform; COP velocity and COP length	60 s in static condition	Preferred leg for kicking a ball	- 25 non-soccer players - 25 soccer players	NDL = DL

Matsuda et al. (2010a)	Force platform; COP velocity and COP length	30 s when standing on stable ground with the free leg rotated around a ball (as near as possible without touching it)	Preferred leg for kicking a ball	- 17 soccer players - 17 students (6 with basket-ball experience, 5 with swimming experience and 6 with no technical exercise experience)	NDL = DL
Matsuda et al. (2008)	Force platform; COP velocity and COP length	60 s in static condition	Preferred leg for kicking a ball	- 10 swimmers - 10 soccer players - 10 basket-ball players - 10 non athletes	NDL = DL
Hoffman et al. (1998)	Force platform; COP surface area and COP length	15 s in static condition	Defined through 3 functional tests: ball kick, step-up and balance recovery after postural perturbation	10 healthy subjects	NDL = DL

COP: Centre of foot of pressure; DL: dominant leg; NDL: non dominant leg

Table 1: Cross-sectional studies showing no differences between the monopedal postural balance of the dominant leg and that of the non-dominant leg in healthy adults. This table relates only results from quantitative analyses of postural balance (centre of pressure parameters, stability indexes, limbs kinematics). No study was listed in the following cases: qualitative analyses, imprecise or very sophisticated methodology, longitudinal follow-ups, fatigue protocol and asymmetry indexes without distinction between the dominant and the non-dominant leg.

	Evaluation technique and measured parameters	Test duration	Definition of the dominant leg	Number and types of subjects	Comparison NDL/DL
Jadcak et al (2019)	Accelerometers; inclination angles	20 s in static condition 30 s in dynamic condition	Self-report measure and a kicking ball test	154 soccer players - 52 professionals - 55 U-21 - 47 U-19	- Static: NDL = DL - Dynamic: NDL >DL
Brown et al. (2018)	Balance SD System; stability index scores	20 s in static (more stable i.e., level 8) and dynamic (less stable i.e., level 2) conditions	Preferred leg for kicking a ball	30 healthy male academy rugby union athletes - 15 forwards - 15 backs	- Static (more stable) Forwards: NDL = DL Backwards: NDL < DL - Dynamic (less stable) No difference
Kovacikova et al. (2015)	Force platform; COP excursion as a function of time	5 s after unexpected postural perturbations	Preferred leg for 1. Kicking a ball, 2. Step onto a 20-cm high step, 3. Balance recovery after disturbance	14 physically active young subjects	Re-stabilization time NDL > DL
Kiyota and Fujiwara (2014)	Force platform; COP velocity	20 s in static and dynamic condition	Determined through the Waterloo Footedness Questionnaire revised	30 healthy young adults	- Static: NDL = DL - Dynamic: NDL < DL
Vieira et al. (2014)	Force platform; COP amplitude	30 s in quiet stance and with unexpected postural perturbations	Leg preference for performing motor skills	12 physically active male university students	- Quiet stance NDL > DL - Perturbed posture NDL = DL
Kartal et al. (2014)	Force platform; COP length	60 s in static condition	Preferred leg for kicking a ball	- 20 tennis players - 20 soccer players - 20 basketball players - 20 volleyball players	Basketball, soccer and volleyball players: NDL > DL
Ricotti et al. (2013)	Force platform; COP length, COP surface area	20 s in static and dynamic condition	Preferred leg for kicking a ball	185 sportsmen including 170 soccer players (15 control subjects)	- Static: NDL > DL - Dynamic : NDL >DL
Lin et al. (2013)	Motion analysis, 3-dimension trajectories of markers; inclination angle of rotation axis	10 trials (pirouettes), 5 trials on the dominant leg and 5 trials on the non-dominant leg	Preferred leg for kicking a ball	- 13 experienced dancers - 13 novice dancers	- Experienced dancers NDL < DL - Novice dancers DL = NDL
Baron et al. (2011)	Force platform; COP surface area	5 s in static condition	Preferred leg for kicking a ball	- 20 sedentary subjects - 20 soccer players - 20 basketball players - 20 windsurfer	Only soccer players NDL > DL

COP: Centre of foot of pressure; DL: dominant leg; NDL: non dominant leg

Table 2: Cross-sectional studies showing differences between the monopodal postural balance of the dominant leg and that of the non-dominant leg in healthy adults. This table relates only results from quantitative analyses of postural balance (centre of pressure parameters, stability indexes, limbs kinematics). No study was listed in the following cases: qualitative analyses, imprecise or very sophisticated methodology, longitudinal follow-ups, fatigue protocol and asymmetry indexes without distinction between the dominant and the non-dominant leg.