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Research Article

Biomechanical Effects of Dominant or Nondominant Limb on Asymmetry during Running Stance Phase

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Purpose. This study explores lower limb joint displacement differences during the stance phase and to examine the effects of limb dominance on asymmetry. A total of 32 healthy male amateur marathon runners were recruited (age: 35.33 ± 6.90 years, height: 174.17 ± 3.34 cm, weight: 63.92 ± 4.53 kg). The experiment employed a Vicon eight-camera motion capture system synchronized with an AMTI force plate to record the phase from heel strike to toe-off. The continuous relative phase (CRP) between the dominant and nondominant limbs was assessed using of independent t-test of SPM1d. *Results*. The hip–knee joint of the dominant limb had a larger maximum CRP ($t = 1.104$, $p > 0.05$, effect size $= 0.270$), smaller minimum CRP ($t = -2.672$, $p < 0.05$, effect size $= 0.653$), larger values of mean absolute relative phase (MARF) ($t = 3.275$, $p < 0.05$, effect size $= 0.122$), and deviation phase (DP) ($t = 7.582$, $p < 0.001$, effect size $= 0.717$) than that of the nondominant limb. Comparing the dominant limb of the knee–ankle joints with the nondominant, there are smaller maximum CRP ($t = -0.422$, $p > 0.05$, effect size $= 0.144$), smaller DP ($t = -7.237$, $p < 0.001$, effect size $= 0.754$), a larger minimum CRP ($t = 7.909$, $p < 0.001$, effect size $= 2.704$), and larger MARF ($t = 0.355$, $p > 0.05$, effect size $= 0.801$). Furthermore, during the stance phases, there are significant differences in coordination modes between the dominant limb and nondominant limb of intersegmental joints ($p < 0.05$). *Conclusion*. Throughout different phases of the stance phase, asymmetry in the sagittal plane of lower limb joint displacement is evident. The dominant limb undergoes significant changes in joint leading phase coordination modes, with notably less in-phase coordination compared to the nondominant limb. This predisposes muscles to overstretching, thereby increasing the risk of muscle strains, while the nondominant limb compensates for lower muscle strength. Recognizing and addressing such asymmetries is key to optimizing nondominant limb strength and minimizing muscle overstretching in the dominant limb, leading to improved stability and movement efficiency during marathon running. Consequently, when designing exercise programs or physical therapy, it is crucial to consider limb dominance-related symmetry differences to mitigate the risk of injury resulting from interlimb disparities in motion.

1. Introduction

Asymmetry refers to the imbalance or inconsistency between the left and right limbs of the human body in terms of structure, function, or morphology [1, 2], which includes the difference between dominant and nondominant limbs. The dominant limb refers to one limb that is more inclined to be more dominant during movement and the nondominant limb provides postural stability and support, ensuring balance and coordination in that movement [3, 4]. Limb dominance or nondominance has considerable variations in physical activities [5, 6]. Running is a repeated movement and a widely practiced athletic activity. Participating in consistent, suitable aerobic running exercise can substantially mitigate the onset of various chronic ailments and reduce mortality rates, which has been substantiated by some scientific research [7]. While running confers numerous health benefits, it is noteworthy that many individuals experience injuries in asymmetry due to engaging in high-volume running routines [8].

Emerging research indicates that limb dominance can have discernible impacts on various aspects of exercise injuries [9] and some studies have suggested that segment displacement involving leadership and directional changes may potentially be influenced by limb dominance during exercise [10, 11, 12]. Limb dominance leads to asymmetry in the legs [4]. Previous study results have indicated that lateral shear forces have been affected by asymmetry [13, 14], impacting the limb's support and motion in the sagittal plane [15, 16]. Asymmetry occurs in uneven loading [17] and various coordination modes of intersegmental joints. This also elevates the instability of movements and may result in sports injuries [5, 18, 19]. Therefore, understanding and managing asymmetry can enhance exercise methods and reduce injury risks [20].

Current research about running primarily focuses on assessing coordination variability in individual joints, revealing inherent asymmetries. However, running involves complex interactions among multiple joints in a closed-chain motor action [21], necessitating investigations into relative joint movements to understand kinematic disparities in limb dominance. Continuous relative phase (CRP) quantifies intersegmental coordination by assessing angular variation across joints [22], consolidating various biomechanical parameters into a single variable. In our study, CRP values and their standard deviations describe the angular variation between corresponding joints during the stance phase, offering a comprehensive view of variation throughout running [23, 24]. To assess differences between CRP curves, additional parameters, specifically the mean absolute relative phase (MARF) and deviation phase (DP) were computed. MARF analyzes coordination in multijoint movements by measuring phase relationships between joints to understand movement control coordination and stability [25]. DP, derived from MARF, quantifies the deviation of each joint's phase from the ideal phase [25]. Despite CRP being around for a long time, its application to investigate interlimb asymmetry in running remains limited [23].

Examining the differences in CRP of the lower limb joint between dominant and nondominant limbs during the stance phase provides valuable insights into how limb dominance affects joint coordination patterns, which may lead to asymmetry within this phase. Based on the fact that the dominant limb typically has superior strength and neural attributes compared to its nondominant counterpart [26]. Therefore, the purpose of this study is to examine two hypotheses: (1) there is a noticeable asymmetry between the dominant and nondominant limbs and (2) the dominant limb exhibits more coordinated coordination mode and better stability in the movement than the nondominant limb in the stance phase.

2. Materials and Methods

2.1. Participants. We recruited 32 amateur marathon runners based on calculation results using G*Power 3.1.9 software (effect size: 0.5, $\alpha = 0.05$). Each participant was a hindfoot landing runner who engaged in running activities at least 2–3 times per week and averaged over 20 miles per week. The right foot of the participant was the dominant limb determined by the interview. The participant demographics are presented in Table 1. None of the participants reported any major injuries before 6 months before enrollment in this study. All subjects provided informed consent after approval by the Institutional Review Board of Ningbo University.

TABLE 1: The basic information of participants.

Height (cm)	Weight (kg)	Age (years)
174.17 ± 3.34	63.92 ± 4.53	35.33 ± 6.90

2.2. Experimental Protocol and Procedures. In this study, data were captured during the experimental trials using eight cameras from the VICON motion capture system (Oxford Metrics Ltd., Oxford, UK) at a sampling frequency of 200 Hz. A force plate (AMTI, Watertown, MA, USA) was integrated into the laboratory floor and operated at a sampling rate of 1,000 Hz. While passing through a single-beam timing gate (Brower Timing) with others measure running speed (Figure 1). They also wore tight clothing and according to the Opensim Gait-2392 model, attached 38 reflective markers to their bodies (Table 2). Participants wore a specific brand of running shoes, then underwent a 5-min warm-up and obtained an average for their several running speeds at 14 ± 0.5 km/hr. Participants were instructed to run three times on the ground at this speed. The experimentation included trials for both left and right feet. Valid trials were determined by ensuring full foot contact with the force plate, specifically from heel strike to toe-off, which is defined as the stance phase and excludes trials that involve gait adjustments, incorrect speed or misalignment with the force plate, and improper forefoot impact landings. Finally, 96 valid trials encompassing both dominant and nondominant limbs were collected for subsequent data processing.

2.3. Data Processing. This study focused on the variation of CRP in the sagittal plane, which is of particular interest due to its reliability and significant asymmetry during the stance phase [13, 27, 28]. Employing Vicon Nexus 1.85 software, we captured stance phase data based on dynamics characteristics and subsequently exported C3D files. These files were then adapted into Opensim-compatible formats, and we selected a fourth-order filter in order to protect the biomechanical motion characteristics greatly through MATLAB scripts (MathWorks, Natick, MA, USA). Using Opensim (Sim TK v. 4.3), static calibration was performed and inverse kinematics of joint angle was evaluated, followed by smoothing marker trajectories applying a frequency of 6 Hz. Based on calculated joint angles by Opensim, datasets of CRP, entailing the derivation of normalized angles (θ), normalized angular velocities (ω), and phase angles (Φ) were calculated by Microsoft Excel 2019 version (Microsoft Corporation, Redmond, Washington, USA) [29]. Then, three trials per participant of both left and right leg were averaged, totaling 64 groups (32 trials each for left and right leg). The normalized angle of the hip–knee and knee–ankle was calculated using Equation (1):

$$\theta = 2 \times \frac{\theta_{\text{joint}}}{\theta_{\max} - \theta_{\min}} - \frac{\theta_{\max} + \theta_{\min}}{\theta_{\max} - \theta_{\min}}. \quad (1)$$

The normalized angle velocity of the hip–knee and knee–ankle was calculated using Equation (2):

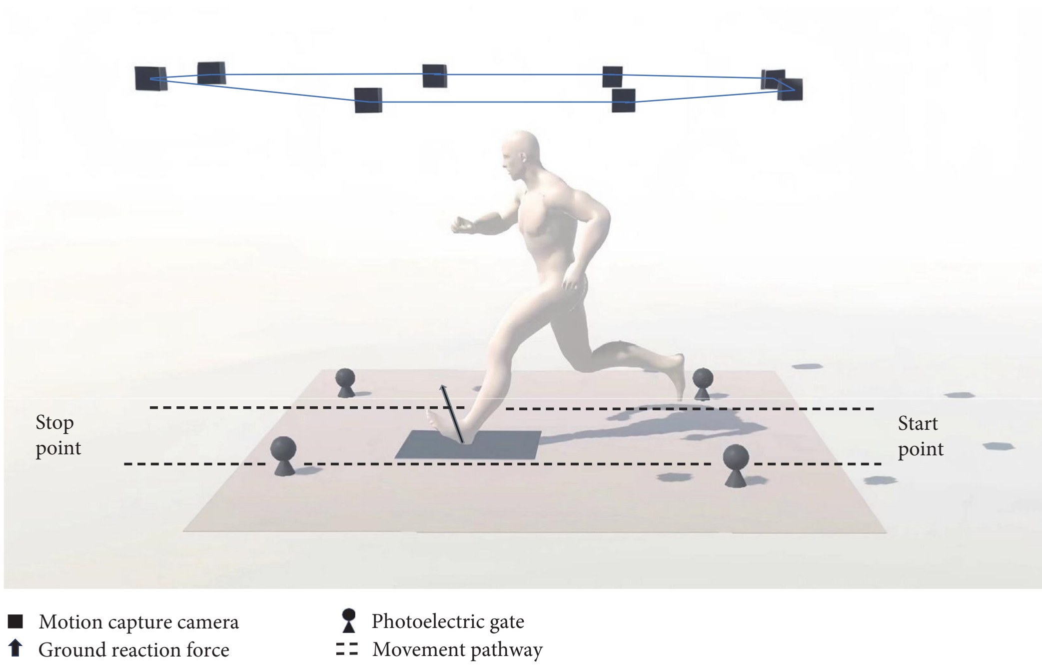

FIGURE 1: Equipment layout.

TABLE 2: Mark position of Opensim Gait-2392 model.

Name of mark	Position
Right and left acromium	The outermost of collarbone at the anatomical position
Sternum	Between the breasts, the base of the sternum
V. Sacral	In the sacrum
Right and left ASIS	The most protruding part of the ilium on the right and left side
Knee lat and med	Lateral tuberosity at the lower base of the femur in the right and left leg
Right and left tight	In the middle of the femur; between the knee. Lat mark and middle of femur; upper of the one-third bottom-up femur in the right and left leg
Right and left shank	Lateral head of tibial; upper head of tibial; lateral head of fibula in the right and left leg
Ankle lat and med	Fibula, lower rib coarse prolongation in the right and left leg
Right and left midfoot. Med	Between medial cuneiform bone and base of metatarsal bone in the right and left leg
Right and left midfoot. Lat	In the fifth metatarsal bone in the right and left leg
Right and left toe. Sup	Between the base of the first phalanx and the head of the metatarsal bone in the right and left leg
Right and left toe. Lat	Trochlea of the fifth phalanx in the right and left leg
Right and left toe tip	Between the first and second tuberosity of the phalanx in the right and left leg
Right and left heel	The most protruding part of the calcaneus in the right and left leg

$$\omega = \frac{\theta_n - \theta_{n-1}}{\Delta_{\text{time}}}. \tag{2}$$

If the normalized angle exceeds 0, the phase angle was calculated using Equation (3):

$$\varnothing = 180 - \left| \left[\arctan \frac{\omega}{\theta} \right] 57.3 \right|. \tag{3}$$

If the normalized angle is less than 0, the phase angle was calculated using Equation (4):

$$\varnothing = \left| \left[\arctan \frac{\omega}{\theta} \right] 57.3 \right|. \tag{4}$$

The CRP is determined by calculating the difference between the proximal minus distal phase angles. Then, using linear interpolation standardize the resulting CRP data to 101 units. A positive CRP value indicates that the movement of the proximal joint precedes that of the distal joint, while a negative CRP value signifies the reverse. An absolute CRP value closer to 180° indicates an antiphase coordination mode, while a value nearer to 0° signifies an in-phase mode. Finally, we used Microsoft Excel to calculate the MARF,

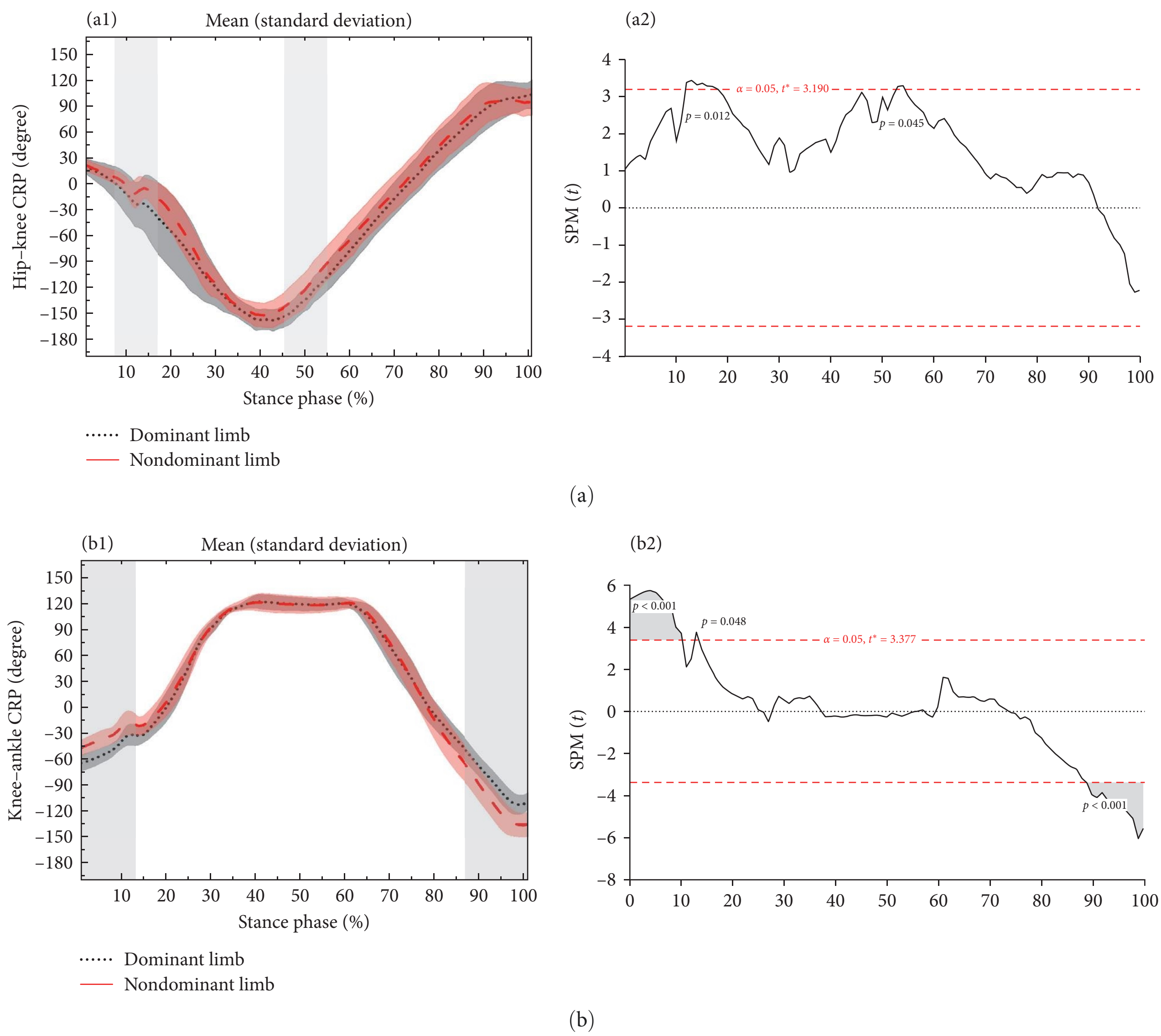

FIGURE 2: (a) CRP curves of the hip–knee joint during the stance phase. (b) CRP curves of the knee–ankle joint during the stance phase. (a2, b2) are one-dimensional statistical parametric maps of hip–knee and knee–ankle joints individually. *Note*. The curve represents the mean; the shaded bars indicate the corresponding standard deviations while shadow boxes indicate statistically significant differences ($^*p < 0.05$).

which is the mean absolute value of each CRP curve during the stance phase, and the DP which is the average of standard deviation on the mean CRP curve. A smaller MARP indicates a closer in-phase coordination pattern between two joints, while a smaller DP signifies smaller variability and better stability in the motion [30].

2.4. Statistical Analysis. In this study, a paired samples t-test from the SPM1d open-source script (www.spm1d.org) was used to analyze the statistical difference of CRP values between the left and right limbs in MATLAB, serving as a parameter of limb asymmetry. Following standardization, the average CRP values which are from both legs of all the participants are analyzed by SPM1d. Subsequently, we used SPSS statistical software (version 27; SPSS, Inc., Chicago, IL, USA) to assess the normality of the data of MARF, DP and maximums, and minimums of CRP and conduct paired samples t-tests comparing these data in both legs of stance phases. This comprehensive analytical approach focused on elucidating coordination and variables of lower joint movements within the sagittal plane during running. Further stance phases were divided into early (first 30%), mid (40%–60%), and late (last 30%) based on the temporal progression of a single stance phase [31].

3. Results

3.1. Comparison of CRP in Dominant Limb versus Nondominant Limb Using SPM1d. In the result of the SPM1d analysis (Paired samples t-test), Figure 2 showed the CRP of lower limb joints that belong to the marathon runner during the stance phase within the sagittal plane. Specifically, there are significant differences in each phase

Table 3: The maximum and minimum of CRP, MARF, and DP in the variables of the joint during the stance phase.

	Joint variables (degree)	Dominant	Nondominant	t-Value	p-Value	Effect size
Max CRP	Hip–knee	115.63 ± 15.20	111.27 ± 16.63	1.104	0.274	0.270
	Knee–ankle	125.50 ± 6.18	126.46 ± 6.65	−0.422	0.675	0.144
Min CRP	Hip–knee	-165.87 ± 9.41	-157.82 ± 14.57	−2.672	0.010*	0.653
	Knee–ankle	-119.78 ± 8.35	-146.09 ± 10.00	7.909	<0.001*	2.704
MARF	Hip–knee	37.43 ± 11.66	29.29 ± 7.80	3.275	0.002*	0.122
	Knee–ankle	29.97 ± 6.01	29.06 ± 7.96	0.355	0.724	0.801
DP	Hip–knee	19.61 ± 7.50	15.54 ± 6.42	7.582	<0.001*	0.717
	Knee–ankle	11.59 ± 5.02	13.66 ± 5.14	−7.237	<0.001*	0.754

*Indicates a significant difference.

between CRP of the dominant and nondominant limb. Figure 2(a1) presents CRP analysis of the hip–knee joint, including its mean and standard deviation, meanwhile, Figure 2(b1) shows the curve of the knee–ankle joint within the same investigation.

The CRP curve illustrates the coordination pattern between the dominant and nondominant limbs during the stance phase in Figure 2. The result for the CRP of the hip–knee joints is offered in Figure 2(a1). Before the 23% mark of the early stance phase, the hip leads the motion. From the 23% of the early stance phase to the midstance phase the knee leads until reaching the late stance phase, with the hip taking the lead. In-phase coordination mode denotes harmonious limb joint movement in the same direction, while antiphase coordination mode signifies contrasting limb joint movement. Additionally, an in-phase mode is observed in the initial 23% of the early stance phase, transitioning to an antiphase mode within 23%–37% of that. The subsequent 37%–50% of the early stance phase displays in-phase coordination mode and knee leading, followed by knee-led antiphase coordination mode from 50% of the early stance phase to the initial midstance phase. After the initial midstance phase, a gradual shift toward 0° indicates a progression to in-phase coordination mode. In the late stance phase, the antiphase mode persists until toe-off.

Figure 2(b1) concurrently presents the result for the CRP of the knee–ankle joints. Initially, during 64% of the early stance phase, the ankle is ahead in motion, affecting in-phase coordination mode. After surpassing 64% of the early stance phase, the knee joint leads the coordination in an antiphase mode. Within the late stance phase, the knee–ankle joint is in an in-phase coordination mode, maintaining this arrangement until the initial late stance phase. After that the knee–ankle joint transits into the antiphase pattern, leading with the ankle.

3.2. Results of Average Extreme CRP Values about Lower Limbs within the Sagittal Plane. The CRP differences of the mean maximum and minimum between the dominant and nondominant leg are presented in Table 3. Specifically, in terms of kinematics variables, Table 3 presents the minimum CRP associated with lower limbs, examining the disparities among the hip joint, the knee joint, and the ankle joint. In comparison to the dominant limb, the nondominant limb exhibits a larger minimum CRP ($t = -2.672$, $p < 0.05$, effect size = 0.653). While the knee–ankle joint of the dominant limb has a smaller maximum CRP than its nondominant limb, its minimum is notably larger in comparison ($t = 7.909$, $p < 0.001$, effect size = 2.704). Additionally, the maximum CRP showed that the hip–knee join of the dominant limb is larger than that of the nondominant limb ($t = 1.104$, $p > 0.05$, effect size = 0.270). The maximum CRP value within the knee–ankle joint of the dominant limb is smaller compared to that of the nondominant limb ($t = -0.422$, $p > 0.05$, effect size = 0.144). Concurrently, Table 3 presents the outcomes of MARF and DP in the variables of the joint during the stance phase. MARF values show that the nondominant limb within the hip–knee joint ($t = 3.275$, $p < 0.05$, effect size = 0.122) and knee–ankle joint ($t = 0.355$, $p > 0.724$, effect size = 0.801) are smaller than the nondominant limb. Additionally, the DP value within the hip–knee joint of the nondominant limb is smaller compared to that of the dominant limb ($t = 7.582$, $p < 0.001$, effect size = 0.717). The knee–ankle joint of the nondominant limb is larger than that of the dominant limb ($t = -7.237$, $p < 0.001$, effect size = 0.754).

Lastly, Figure 3 presents the percentage of the coordination mode in the variables of the joint during the stance phase. The in-phase coordination mode is more in the nondominant limb than in the dominant limb. A significant difference exists in the proximal joint leading phase of the knee–ankle joint and the distal joint leading phase of the hip–knee joint. The t-value, p-value, and effect size of the phase percentage are outlined in Table 4.

4. Discussion

This study aimed to investigate asymmetries using CRP during the stance phase, to discover the effects of limb dominance on asymmetry. Previous research findings suggest that asymmetries exist in both the morphology and functionality of the human body [32, 33]. Yekini and Grace [34] revealed that connecting with temporal parameters, asymmetries of the lower limbs exist in the knee–ankle joint of long-distance runners. Carpes et al. [35] also reported the existence of asymmetry between dominant and nondominant limbs in different exercise intensities. Building upon this, our study aligns with previous investigations that revealed asymmetries. Figure 2 with time series demonstrates a similar motive mode in the

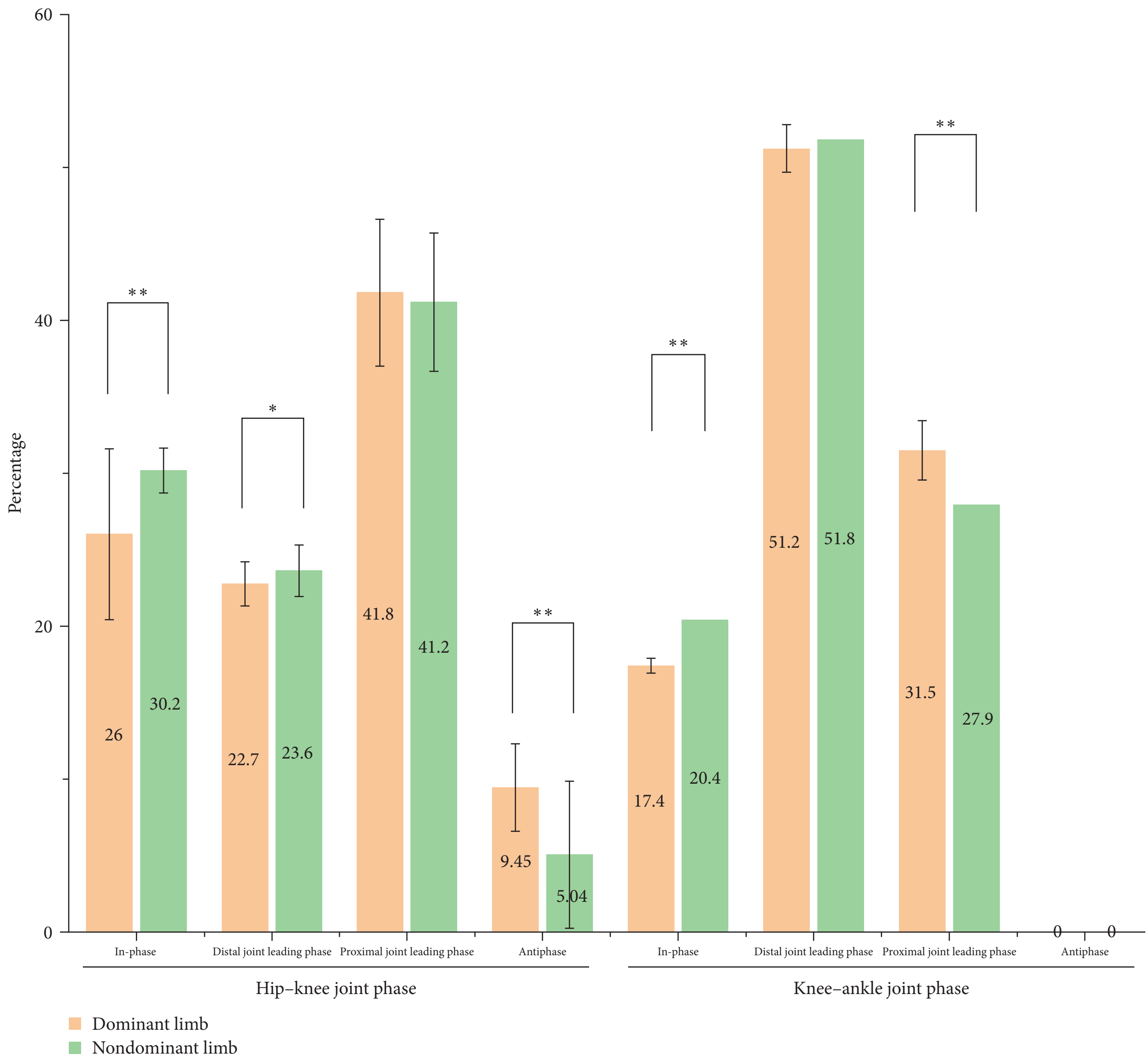

Figure 3: The percentage of the coordination mode. There are in-phase, out-phase, and antiphase. The out-phase includes the distal joint leading phase and proximal joint leading phase. *Indicates significant difference ($p < 0.05$); **indicates the significant difference ($p < 0.01$); and the numbers indicate the percentage of the phase (%).

Table 4: The t-value, p-value, and effect size of the phase percentage.

Type of phase	Joint variables	t-Value	p-Value	Effect size
In-phase	Hip–knee	−4.24	<0.001*	4.23
	Knee–ankle	5.27	<0.001*	1.68
Distal joint leading phase	Hip–knee	−2.24	<0.05*	1.58
	Knee–ankle	1.29	0.21	1.33
Proximal joint leading phase	Hip–knee	0.55	0.58	4.74
	Knee–ankle	−4.01	<0.001*	2.63
Antiphase	Hip–knee	−4.59	<0.001*	3.96
	Knee–ankle	—	—	—

*Indicates a significant difference.

lower limb joint displacement and intersegmental coordination during all the stance phases. Through analyzing Table 3 and Figure 3, we find that although both legs have the same coordination mode, the level of the coordination and percentage of the different phases are different. Meanwhile, significant differences in their motion variability during movement were observed between the dominant and nondominant limbs. The dominant limb may have greater variance leading to the difference in the out-phase percentage, so asymmetries exist in lower limbs. The anatomical and structural characteristics of the joints limit the angular motion variation to a certain extent [34]. However, some scholarly investigations indicate a lack of significant asymmetry at the level of individual joints [36, 37] and other studies found differences in the intersegment. The insignificance difference of lower limb asymmetry might arise from the possibility that individual joints within the lower limb are compensated or counteracted by the movements of other joints during specific activities. For example, when people move their bodies, their joints do not move individually, but rather exhibit intersegmental coordination in the movement [21]. It is important to analyze the motive and coordination mode among multiple joints in lower limb motion analysis for a comprehensive understanding of the impacts of asymmetry. Recognizing that slight differences at individual joints during motion can cumulatively contribute to significant overall asymmetry.

The dominant and nondominant limbs are prone to experiencing different injuries [2, 38] due to slight differences in coordination mode. As illustrated in Table 3 and Figure 3, during the stance phase, the dominant limb exhibits less in-phase coordination mode and relies more on the antiphase and out-of-phase coordination modes of the proximal joint leading phase. Moreover, it exhibits a heightened reliance on the knee joint in contrast to the ankle joint. During the lower limb's stance phase, the hip, knee, and ankle joints experience stimulation from the ground reaction force, akin to a compressed spring. The dominant limb demonstrates effectively absorbs ground impacts through the knee joint which is a hinge joint [2, 38, 39]. However, the characteristic of the out-phase coordination mode entails movements occurring in different directions or at different time points, thereby predisposing muscles to overstretching and increasing the likelihood of muscle strains. These may explain why numerous studies have indicated a higher risk of injury associated with the dominant limb [40]. In-phase coordination modes, because they provide greater resultant force, tend to be used when stability is needed and to help balance the body [41]. The nondominant limb has a larger percentage of in-phase coordination mode (Figure 3) and in the early stance phase, it is closer to in-phase coordination mode than the other (Figure 2). Although some studies revealed that less variable and in-phase interjoint coordination mode might not be conducive to absorbing the collision load, so induces cartilage tissue to experience more stress and increases the injury risk [40, 42, 43]. In my opinion, the most important reason is that the strength of the nondominant limb cannot match that of the dominant limb [44] and compensates for disadvantage by coordination mode like compensatory mechanisms [45]. To achieve as same as the support of the dominant limb, the load that does not match the capacity of the nondominant limb will be easy to be injured. In the late stance phase, it is further demonstrated that with a more negative CRP value with its absolute CRP value approaching 180° (as depicted in Figure 2). This indicates a higher reliance on the ankle joint of the nondominant limb, approaching an anticoordination mode. The supportive nature of the ankle joint and the symmetrical joint properties of the anticoordination mode are both conducive to maintaining standing posture [41]. When we are landing on our heels, we need a certain amount of strength to support our body and then complete a full foot roll. However, the nondominant limb changes phase coordination mode later than the other, which indicates poorer rolling on the ground. Due to insufficient strength, more time is required to maintain stability during the movement probably, resulting in less flexibility compared to the dominant limb. Same as studies of Gao et al. [45] and Pappas et al. [46] that compensatory mechanisms maintain gait stability and restrict body movements, respectively. Therefore, the coordination modes of the dominant and nondominant limbs may exhibit slight differences, the nondominant limb has inferior muscle strength and flexibility [38], and the demands of marathon races require each limb to repeatedly engage in tasks it may not be optimally suited for, consequently elevating the risk of injury.

Notably, the results did not align with our second hypothesis which is the dominant limb exhibits a more coordinated coordination mode in the movement. Instead, to compensate for insufficient strength and motion control in movement, the nondominant limbs need more in-phase and coordinated joint movements and more time to maintain balance than the dominant limb in running, to compensate for insufficient muscle strength in movement. In other words, it could be a sacrifice of flexibility to compensate for the disadvantages of muscle strength.

However, further investigation is needed to determine whether asymmetry might increase the risk of injury in the lower limb. Additionally, regarding the development of athletic skills, understanding the relationship between coordination mode and asymmetry holds practical significance for athletes and coaches. They can consciously adapt and utilize asymmetry to enhance or reduce compensation, thereby fostering stable and correct changes in coordination mode and ultimately improving competitive performance.

Additionally, several limitations require consideration within the scope of this study. First, in the present investigation, the examination of the CRP of the ankle–hip joint was not within the scope of inquiry. Our study primarily focused on meticulous analysis and exploration of kinematic data while affording relatively less attention to an extensive inquiry into kinetic aspects. This distinction could potentially limit the breadth of our overall understanding concerning human locomotion. Furthermore, equipment limitations prevent us from acquiring data from both sides of the same gait sequence. Lastly, it is noteworthy that we refrained from incorporating an assessment of the thigh angle's influence on hip joint kinematics.

Future research endeavors could incorporate more-level marathon runners for comprehensive comparisons. We hope that researchers undertake a protracted longitudinal follow-up study, alongside the prospective inclusion of kinetic data analysis, to generate conclusions that are both comprehensive and precise. Athletic training and rehabilitation strategies are expected to adapt toward realistic and individualized situations as they need to take into account the individual data.

5. Conclusions

Throughout different phases of the stance phase, asymmetry in the sagittal plane of lower limb joint displacement is evident. The dominant limb undergoes significant changes in joint leading phase coordination modes, with notably less in-phase coordination compared to the nondominant limb. This predisposes muscles to overstretching, thereby increasing the risk of muscle strains, while the nondominant limb compensates for lower muscle strength. Recognizing and addressing such asymmetries are key to optimizing nondominant limb strength and minimizing muscle overstretching in the dominant limb, leading to improved stability and movement efficiency during marathon running. Consequently, when designing exercise programs or physical therapy, it is crucial to consider limb dominance-related symmetry differences to mitigate the risk of injury resulting from interlimb disparities in motion.

Data Availability

The data that support the findings of this study are available upon request. We are committed to making our data accessible and reproducible, and we encourage interested researchers to contact us for more information.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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