

## Dynamic Balance and Leg Muscle Power Associated with Momtong Dollyo Chagi Speed in Taekwondoin

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### Abstract

**Background:** Momtong dollyo chagi requires rapid lower limb movement and postural control, yet evidence on the associations of dynamic balance and leg muscle power with kick speed remains limited.

**Objective:** To examine the associations of dynamic balance and leg muscle power with momtong dollyo chagi speed among Taekwondoin.

**Methods:** This analytical cross-sectional study included 41 Taekwondoin aged 5 to 18 years from Semesta Taekwondo Club Gianyar, Indonesia, recruited through total population sampling. Dynamic balance, leg muscle power, and kick speed were assessed using the Modified Bass Test, Standing Broad Jump Test, and a five-kick momtong dollyo chagi speed test, respectively. All participants had complete data. Associations between categorized variables were re-examined using Fisher's exact test because of sparse cells and zero frequencies. Cramer's V and bootstrap 95% confidence intervals were used to describe association strength.

**Results:** Dynamic balance was associated with kick speed ( $p = 0.012$ ; Cramer's  $V = 0.461$ ; 95% CI, 0.00 to 0.81). Leg muscle power was also associated with kick speed after exact reanalysis ( $p = 0.036$ ; Cramer's  $V = 0.408$ ; 95% CI, 0.34 to 0.63). Most participants had good dynamic balance (92.7%), moderate leg muscle power (51.2%), and excellent kick speed (68.3%).

**Conclusion:** Dynamic balance and leg muscle power were associated with momtong dollyo chagi speed in this sample. The findings do not establish causality and should be interpreted cautiously because of the small sample and uneven category distributions.

### Keywords

Taekwondo; Postural Balance; Muscle Strength; Athletic Performance; Cross-Sectional Studies

### Introduction

Taekwondo is a martial art and combat sport that requires the integration of technical skill, physical capacity, and motor control to support performance during training and competition.<sup>1</sup> Kicking techniques play a central role in Taekwondo because they are widely used as offensive actions to score points.<sup>2</sup> One commonly performed technique is momtong dollyo chagi, a circular kick directed toward the opponent's trunk, typically using the instep as the striking surface.<sup>3</sup> Effective execution of this technique requires not only rapid movement but also adequate control of body position throughout the support, rotation, and kicking phases.<sup>1,4</sup>

Kicking speed is an important component of momtong dollyo chagi performance because rapid execution may influence the effectiveness of an attacking movement in a competitive setting.<sup>2</sup> However, kicking speed should not be considered an isolated physical capacity. The execution of a rapid kick involves the coordinated interaction of physical and technical factors, including lower limb movement, postural control, intersegmental coordination, and the ability to maintain stability while transferring body mass.<sup>1</sup> Previous studies in Taekwondo have suggested that physical characteristics and training interventions targeting specific physical capacities may be associated with changes in kicking performance, including dollyo chagi speed.<sup>1,5</sup> Therefore, identifying physical factors associated with kicking speed may contribute to a better understanding of performance characteristics in Taekwondo.

Dynamic balance is one physical component that may be relevant to the execution of momtong dollyo chagi.<sup>6</sup> During kicking, the athlete must maintain postural stability on the supporting limb while the contralateral limb performs a rapid and rotational movement.<sup>7</sup> This task requires continuous control of body position despite changes in the center of mass and the mechanical demands generated by the kicking action.<sup>4</sup> Evidence from Taekwondo research suggests that postural control and balance characteristics are relevant to the execution of kicking movements and may vary according to skill level and training demands.<sup>6</sup> These findings provide a biomechanical rationale for considering dynamic balance as a factor potentially associated with kicking performance.

Evidence specifically examining the association between dynamic balance and kicking speed in Taekwondo, however, remains limited. Widyastuti et al. reported a contribution of dynamic balance to dollyo chagi kicking speed among Taekwondoin.<sup>8</sup> Other studies involving Taekwondo kicking techniques have also suggested relationships between balance-related abilities and kicking performance.<sup>6</sup> Nevertheless, differences in kicking techniques, participant characteristics, measurement instruments, and training contexts limit the direct generalization of these findings to momtong dollyo chagi.<sup>2</sup> Consequently, the available evidence does not yet fully establish whether a similar pattern of association is observed in different Taekwondo populations, particularly among athletes spanning childhood and adolescence.<sup>2</sup>

Leg muscle power may also be associated with kicking performance because explosive lower limb actions require the rapid production and transfer of force.<sup>9</sup> From a theoretical perspective, the ability to generate force quickly may contribute to lower limb acceleration during the execution of a kick.<sup>9</sup> Previous studies involving Taekwondo athletes have reported relationships between leg muscle power and dollyo chagi performance, and training programs targeting lower limb physical capacity have been associated with improvements in explosive performance and kicking ability.<sup>1,5</sup> However, findings from these studies cannot be interpreted as evidence

that leg muscle power is consistently associated with kicking speed across all Taekwondo populations. Differences in age, biological maturation, training experience, technical proficiency, and measurement procedures may influence the observed relationships.<sup>10</sup>

The relationship between leg muscle power and kicking speed should also be interpreted within the context of the complex biomechanical nature of Taekwondo kicking. The speed of the kicking limb may depend on coordinated movement across multiple body segments rather than on the capacity of a single muscle group. Factors such as intersegmental coordination, movement sequencing, hip rotation, knee motion, transfer of mechanical energy, postural control, flexibility, and technical proficiency may all contribute to the final characteristics of the kick.<sup>11</sup> Biomechanical studies of Taekwondo kicking have emphasized the importance of coordinated movement and lower limb kinematics in achieving effective kicking performance.<sup>1</sup> Accordingly, leg muscle power represents one potentially relevant physical component but should not be regarded as the sole determinant of momtong dollyo chagi speed.

Studies from other martial arts, including Pencak Silat, have also reported associations between balance, leg muscle power, and kicking performance.<sup>12,13</sup> These findings may provide conceptual support for the relevance of postural stability and explosive lower limb capacity in kicking movements. However, direct generalization from other combat sports to Taekwondo should be avoided because kicking techniques, movement patterns, target characteristics, competition rules, and performance demands differ across disciplines. Therefore, evidence from other martial arts is considered supportive rather than directly transferable to the present research question. The interpretation of the primary findings of this study is consequently focused on the biomechanical characteristics and empirical evidence relevant to Taekwondo.

The available literature indicates an important research gap. Previous studies have examined dynamic balance, leg muscle power, or kicking performance separately, and some studies have reported associations between these physical components and kicking ability.<sup>1,5</sup> Nevertheless, evidence simultaneously examining dynamic balance and leg muscle power in relation to momtong dollyo chagi speed remains limited, particularly among Taekwondoin aged from childhood to adolescence in a club-based training setting. Differences in participant characteristics, kicking techniques, measurement approaches, and training contexts also limit the comparability of previous findings.

The novelty of the present study lies in examining two relevant physical components, dynamic balance and leg muscle power, in relation to momtong dollyo chagi speed within the same population of Taekwondoin aged 5 to 18 years. By evaluating these variables simultaneously, the study provides empirical information on the pattern of association between physical capacities and kicking performance in the specific population studied. The findings may contribute to a more comprehensive understanding of physical characteristics associated with momtong dollyo chagi performance while recognizing that kicking speed is influenced by multiple physical, technical, and individual factors. Because the study used a cross-sectional design, the observed relationships are interpreted as associations and do not establish causal effects.

Therefore, this study aimed to examine the associations of dynamic balance and leg muscle power with momtong dollyo chagi speed among Taekwondoin at Semesta Taekwondo Club Gianyar.

## Methods

This analytical observational study used a cross-sectional design to examine the associations of dynamic balance and leg muscle power with momtong dollyo chagi speed. Data collection was conducted on January 27, 2026, at the Dojang of Semesta Taekwondo Club Gianyar, Bali, Indonesia.

The source population consisted of 53 members of Semesta Taekwondo Club Gianyar. Total population sampling was used, and all members who met the study eligibility criteria were included. Participants were eligible if they were 5 to 18 years of age, were actively participating in Taekwondo, and had previously participated in at least one Taekwondo competition. Participants with a history of trauma within the previous 6 months were excluded. Of the 53 members assessed, 12 were excluded, including 2 participants with a history of trauma within the previous 6 months and 10 participants who had never participated in a Taekwondo competition. The final analytical sample therefore consisted of 41 participants. Complete data were available for all participants and all study variables; consequently, no missing data procedures were required. No *a priori* sample size calculation was performed because the study used total population sampling within the available club population. The relatively small sample size was subsequently considered when interpreting the findings.

Dynamic balance and leg muscle power were defined as the independent variables, whereas momtong dollyo chagi speed was the dependent variable. Age, sex, and body mass index were recorded as participant characteristics. Other potentially relevant factors, including training duration, training frequency, belt level, and competition level, were not available as complete analytical variables and were therefore not included in adjusted analyses. Because of the small sample size and uneven distribution of several outcome categories, multivariable adjustment for potential confounding was not considered statistically appropriate.

Dynamic balance was assessed using the Modified Bass Test, following the procedure described by Ferdita and Sahri.<sup>14</sup> Participants started at the designated starting point and initially supported their body on one foot. They then jumped alternately between 10 markers, beginning with the right and left feet according to the prescribed pathway. At each marker, participants were required to land with the foot covering the marker and maintain a static position for up to 5 seconds. If balance was lost, the participant returned to the appropriate marker before continuing to the subsequent marker. The distances between markers followed the prescribed Modified Bass Test pattern and were expressed in inches. Each successful landing was awarded up to 5 points, and maintaining balance was awarded up to 5 additional points, with 1 point assigned for each second of balance. The maximum score was 100 points. Each participant completed two trials, with rest provided according to individual readiness, and the best score was used for analysis. Dynamic balance was categorized according to the Modified Bass Test criteria of 14–31 (less), 32–49 (medium), and 50–68 (good), as reported in recent literature.<sup>15</sup> The previously reported validity and reliability values were 0.969 and 0.960, respectively, based on the source used in the original study; however, the type of coefficient and validation population require verification before final reference validation.<sup>14</sup>

Leg muscle power was assessed using the Standing Broad Jump Test. Participants stood with both toes immediately behind the starting line and the knees slightly flexed. When ready, they swung both arms forward and jumped as far as possible, landing simultaneously on both feet. Jump distance was measured from the inner edge of the starting line to the nearest point of foot contact with the ground, corresponding to the posterior heel position. Each participant completed two trials, and the best distance was used for analysis. Rest between trials was provided according to individual readiness. The measurement procedure was based on the protocol reported by Astuti et al. and Sina and Pelariyanto.<sup>16</sup> Leg muscle power was categorized using sex-specific criteria reported in the source applied in the original study, whereas age-specific categorization was not used.<sup>17</sup> The reported validity and reliability

values were 0.607 and 0.963, respectively, based on Sina and Pelariyanto; the type of coefficient and characteristics of the validation population require verification during the final reference quality assessment.<sup>18</sup>

Momtong dollyo chagi speed was assessed using a five-kick speed test, with the measurement procedure adapted from the protocol used in previous Taekwondo research.<sup>19</sup> Participants assumed a sideways or fighting stance behind a Taekwondo target pad positioned at abdominal height. The distance from the participant to the target was adjusted according to individual kicking reach. The stronger or preferred kicking leg was positioned behind and used for all trials. Following the start command, participants performed five consecutive momtong dollyo chagi kicks against the target while the elapsed time was recorded using a stopwatch. Timing began when the first kick contacted the target and ended immediately after completion of the fifth kick. A kick performed with an incorrect technique or without valid contact with the target was not scored. Each participant completed three trials, with rest provided according to individual readiness, and the best performance was used for analysis. Two assessors were involved, with one assessor recording the time and the other holding the target. The reported validity and reliability values of the test were 0.750 and 0.707, respectively, based on the source used in the original study. The categories of kick speed were also derived from the same source.<sup>20</sup>

Before data collection, the assessors received standardization regarding the measurement procedures. Two assessors were involved in each measurement session. The condition and readiness of all equipment, including measuring devices, tape markers, the target pad, and stopwatch, were checked before use. Formal instrument calibration was not performed because the equipment consisted of simple measurement and testing materials. All participants received the same testing procedures and standardized instructions to promote consistency and reduce measurement variability. The three measurements were performed according to the study protocol, consisting of the Modified Bass Test, Standing Broad Jump Test, and momtong dollyo chagi speed test.

Participant characteristics and study variables were summarized using frequencies and percentages. The original analysis used the chi-square test with a two-sided significance level of 0.05, and expected cell counts were checked before analysis. However, because the contingency tables contained sparse cells and zero frequencies, the final inferential analysis was based on an exact method appropriate to the structure of the contingency tables. The statistical analysis reported the corresponding exact p values and measures of association with 95% confidence intervals. Associations were interpreted as statistically significant when  $p < 0.05$ . Because the study used a cross-sectional design, all statistical findings were interpreted as associations and not as evidence of causality.

The study received ethical approval from the Ethics Committee of Universitas Bali Internasional, with approval number 02.0631/UNBI/EC/I/2026. Before testing, participants received an explanation of the study objectives, testing procedures, and relevant participation requirements. Participants who agreed to participate signed the consent form, and the coach acted as a witness to the consent process. For participants younger than 18 years, the available study documentation indicates that assent was obtained directly from the participants after the procedures had been explained. The available documentation does not indicate that written consent was obtained from a parent or legal guardian; therefore, this aspect should be reviewed against the requirements of the approving ethics committee before final submission.

## Results

A total of 53 members of Semesta Taekwondo Club Gianyar were assessed for eligibility. Twelve individuals were excluded because 2 had a history of trauma within the previous 6 months and 10 had never participated in a Taekwondo competition. The remaining 41 participants met the eligibility criteria and were included in the analysis. Complete data were available for all participants; therefore, no participants were excluded because of missing data. The participant selection process is presented in Figure 1.

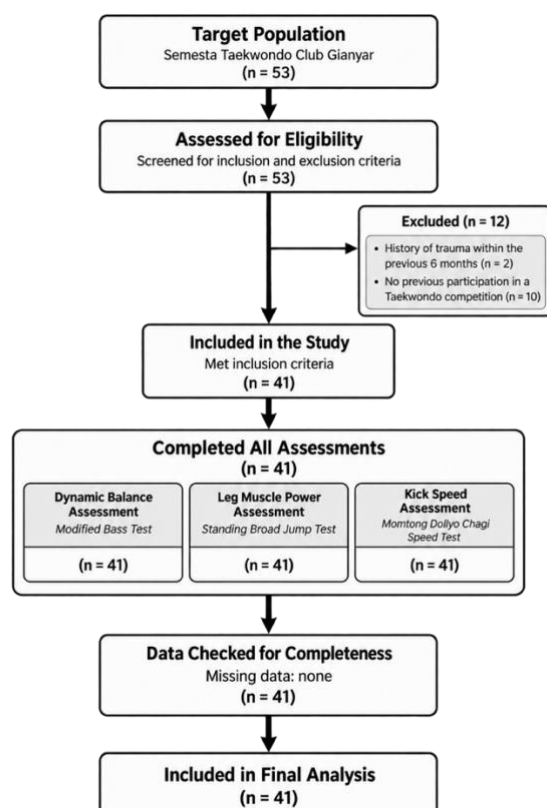


**Figure 1.** Flow Diagram of Participant Selection and Inclusion in the Study

Figure 1 illustrates the progression from the source population to the final analytical sample. Of the 53 eligible club members assessed, 77.4% were included in the study. All 41 included participants completed the measurements of dynamic balance, leg muscle power, and momtong dollyo chagi speed and were retained in both association analyses.

Participant characteristics and the distributions of the study variables are summarized in Table 1. Most participants were adolescents aged 10 to 18 years (85.4%), while 14.6% were children aged 5 to 9 years. The sample included 23 male participants (56.1%) and 18 female participants (43.9%). Based on body mass index classification, 22 participants (53.7%) were categorized as underweight, whereas 16 participants (39.0%) were classified as having normal body mass index. Only three participants were classified as overweight or obesity I.

The distributions of the primary study variables were uneven across several categories. Most participants demonstrated good dynamic balance (92.7%), whereas only three participants (7.3%) were categorized as having moderate dynamic balance. Leg muscle power showed a broader distribution, with the largest proportion of participants classified in the moderate category (51.2%). Regarding momtong dollyo chagi speed, 28 participants (68.3%) were classified as excellent, followed by 7 participants (17.1%) in the good category and 6 participants (14.6%) in the moderate category. These distributions provide the context for the association analyses presented in Tables 2 and 3.

The relationship between dynamic balance and momtong dollyo chagi speed is presented in Table 2. Participants with good dynamic balance were predominantly classified as having excellent kick speed, accounting for 28 of 38 participants in this category. In contrast, none of the three participants with moderate dynamic balance were classified in the excellent kick speed category; one was classified as having good kick speed and two as having moderate kick speed.

Because the contingency table contained a sparse cell and a zero frequency, the association was evaluated using an exact method rather than relying on the original chi-square result. The final analysis showed a statistically significant association between dynamic balance and momtong dollyo chagi speed ( $p = 0.012$ ). The strength of the association was described by Cramer's V of 0.461, with a bootstrap 95% confidence interval of 0.00 to 0.81. The wide confidence interval indicates substantial uncertainty in the magnitude of the association, which is consistent with the small sample size and the highly uneven distribution of dynamic balance categories.

**Table 2.** Association Between Dynamic Balance and Momtong Dollyo Chagi Speed

| Dynamic balance | Excellent, n | Good, n | Moderate, n | Total, n |
|-----------------|--------------|---------|-------------|----------|
| Moderate        | 0            | 1       | 2           | 3        |
| Good            | 28           | 6       | 4           | 38       |
| Total           | 28           | 7       | 6           | 41       |

Exact test  $p = 0.012$ ; Cramer's  $V = 0.461$ ; bootstrap 95% CI, 0.00 to 0.81.

The association between leg muscle power and momtong dollyo chagi speed is presented in Table 3. Participants with moderate leg muscle power constituted the largest group, and most of these participants were classified as having excellent kick speed. Participants with good or excellent leg muscle power were also predominantly represented in the excellent kick speed category, whereas the distribution among participants with poor and very poor leg muscle power was more dispersed across the three kick speed categories.

The original chi-square analysis was affected by several sparse cells and zero frequencies. Therefore, the association was re-examined using an exact method appropriate for the observed table structure. The final analysis indicated a statistically significant association between leg muscle power and momtong dollyo chagi speed ( $p = 0.036$ ). Cramer's V was 0.408, with a bootstrap 95% confidence interval of 0.34 to 0.63, indicating that the observed association should be interpreted together with the uncertainty arising from the small sample and uneven category frequencies.

**Table 3.** Association Between Leg Muscle Power and Momtong Dollyo Chagi Speed

| Leg muscle power | Excellent, n | Good, n | Moderate, n | Total, n |
|------------------|--------------|---------|-------------|----------|
| Excellent        | 1            | 0       | 0           | 1        |
| Good             | 8            | 0       | 0           | 8        |
| Moderate         | 15           | 3       | 3           | 21       |
| Poor             | 4            | 2       | 1           | 7        |
| Very poor        | 0            | 2       | 2           | 4        |
| Total            | 28           | 7       | 6           | 41       |

Exact test  $p = 0.036$ ; Cramer's  $V = 0.408$ ; bootstrap 95% CI, 0.34 to 0.63.

Overall, the final analyses indicated statistically significant associations between both dynamic balance and leg muscle power and momtong dollyo chagi speed in this sample. However, the findings should be interpreted cautiously because the analyses were based on categorized variables with uneven distributions, including sparse and zero cells. The results describe cross-sectional associations and do not demonstrate that either dynamic balance or leg muscle power causes differences in kick speed.

## Discussion

The present study examined the associations of dynamic balance and leg muscle power with momtong dollyo chagi speed among 41 Taekwondo. The final analyses indicated statistically significant associations between dynamic balance and kick speed, as well as between leg muscle power and kick speed. However, these findings should be interpreted as cross-sectional associations rather than evidence of causal relationships. In addition, the small sample size, uneven category distributions, and sparse cells in the contingency tables resulted in substantial uncertainty around the estimated association measures. Therefore, the findings provide preliminary evidence regarding factors associated with kicking performance in this specific sample rather than definitive evidence applicable to all Taekwondo populations.

The observed association between dynamic balance and momtong dollyo chagi speed is consistent with the biomechanical demands of Taekwondo kicking. During the execution of a roundhouse-type kick, the athlete must maintain stability on the supporting limb while the kicking limb undergoes rapid movement and rotation. Effective postural control may therefore be relevant to the ability to maintain body alignment and coordinate movement during the kicking action. Previous research in Taekwondo has also suggested that balance-related abilities are relevant to kicking performance and motor control.<sup>6</sup> Nevertheless, direct comparison across studies should be made cautiously because previous investigations have differed in participant characteristics, kicking techniques, balance assessments, and definitions of kicking performance.

In the present study, participants with good dynamic balance were predominantly classified as having excellent kick speed, whereas participants with moderate dynamic balance showed a different distribution of kick speed categories. This pattern may indicate that dynamic postural control is associated with the ability to perform momtong dollyo chagi rapidly within this population. However, the dynamic balance categories were highly uneven, with only three participants classified as having moderate balance. The resulting Cramer's V estimate of 0.461 and its wide bootstrap 95% confidence interval indicate that the apparent strength of this association should not be interpreted with excessive precision. Larger studies using continuous measurements of balance and kick performance may provide more stable estimates of the relationship.

Leg muscle power was also significantly associated with momtong dollyo chagi speed. From a biomechanical perspective, rapid kicking requires the generation and transfer of force through coordinated movement of the lower limbs and other body segments. Explosive lower limb capacity may therefore contribute to the acceleration required during the kicking movement. Previous Taekwondo studies have reported relationships between lower limb physical capacity and kicking performance, including dollyo chagi execution.<sup>3,5</sup> However, kicking speed represents a complex performance outcome and cannot be explained solely by leg muscle power. Technical proficiency, hip and trunk rotation, flexibility, movement sequencing, intersegmental coordination, and postural control may also contribute to the speed of the kicking limb.<sup>2</sup>

The distribution of leg muscle power categories provides additional context for interpreting this finding. Most participants were classified as having moderate leg muscle power, while very few were classified in the highest category. The association analysis also involved several sparse cells and zero frequencies, requiring the use of an exact method rather than reliance on the original chi-square analysis. Although the final analysis indicated statistical significance and a Cramer's V of 0.408, the categorical structure of the data limits the precision with which the underlying relationship can be described. Categorization may reduce statistical information and can obscure variation that would be retained if the original continuous measurements were analyzed.<sup>21</sup> Future studies should therefore consider continuous analytical approaches when the distributional characteristics and sample size permit.

The findings regarding both dynamic balance and leg muscle power should also be considered together. Taekwondo kicking is not dependent on a single physical attribute. Dynamic balance may be relevant to controlling body position and maintaining stability during the kicking sequence, whereas leg muscle power may contribute to the rapid generation of lower limb movement. These components may operate alongside technical and biomechanical factors rather than independently determining kick speed. The present study did not evaluate interactions among these variables and did not establish whether one factor mediates or modifies the association between another physical capacity and kicking performance. Accordingly, the results should not be interpreted as demonstrating a mechanistic pathway.

Several potential confounding factors could not be fully addressed in the present analysis. Age, sex, biological maturation, body size, training duration, training frequency, belt level, competitive experience, technical proficiency, and physical conditioning may influence both the physical capacities evaluated and kick speed. Although age, sex, and body mass index were recorded as participant characteristics, the available sample size and uneven distribution of outcome categories did not support stable multivariable adjustment. Other potentially relevant training variables were not available as complete analytical variables. Consequently, residual confounding remains an important limitation, and the observed associations may partly reflect characteristics not measured or not included in the analysis.

The study has several additional limitations. First, the use of total population sampling from a single Taekwondo club reduced sampling selection within the available population but limits external generalizability. Participants may differ from Taekwondoin from other clubs, competitive levels, geographic areas, or training systems. Second, the analytical sample was small, which reduced statistical precision and contributed to sparse contingency tables. Third, the categorization of dynamic balance, leg muscle power, and kick speed may have reduced information and created uneven distributions across categories. Fourth, the cross-sectional design prevents determination of temporal sequence and does not permit causal inference. Finally, although standardized procedures were used during data collection, the applicability of the reported validity, reliability, and category criteria to participants aged 5 to 18 years requires careful interpretation and final verification of the underlying measurement sources.<sup>22</sup>

Despite these limitations, the study provides information on physical characteristics associated with momtong dollyo chagi speed within a club-based population of children and adolescents practicing Taekwondo. The findings suggest that dynamic balance and leg muscle power may be relevant correlates of kick performance and may be considered when describing the physical profile of Taekwondoin. These results should not be interpreted as evidence that improving either component will necessarily increase kick speed. Longitudinal and experimental studies with larger and more diverse samples are required to determine temporal relationships and to evaluate whether changes in these physical capacities are associated with changes in momtong dollyo chagi performance.

Overall, the findings indicate that dynamic balance and leg muscle power were statistically associated with momtong dollyo chagi speed in the studied sample. The interpretation is strengthened by the use of an exact approach for contingency tables containing sparse cells, but the small sample, categorical analysis, wide uncertainty around the association estimates, and lack of multivariable adjustment remain important considerations. Future research should use adequately powered samples, retain continuous measurements when appropriate, incorporate relevant confounding variables, and evaluate Taekwondo-specific performance outcomes using well-documented measurement procedures.

## Conclusion

This study found that dynamic balance and leg muscle power were statistically associated with momtong dollyo chagi speed among 41 Taekwondoin at Semesta Taekwondo Club Gianyar. Participants with better dynamic balance and different levels of leg muscle power showed significantly different distributions of kick speed categories. The associations remained statistically significant after the use of an exact analytical approach appropriate for contingency tables containing sparse cells and zero frequencies.

These findings suggest that dynamic balance and leg muscle power may represent relevant physical characteristics associated with momtong dollyo chagi performance in the population studied. However, neither variable should be interpreted as the sole determinant of kick speed because Taekwondo kicking performance is also influenced by technical skill, intersegmental coordination, movement mechanics, and other individual characteristics.

The findings should be interpreted cautiously because of the cross-sectional design, small sample size, uneven category distributions, use of categorized variables, and the absence of multivariable adjustment for potential confounding factors. Therefore, the observed associations do not establish temporal relationships or causality and cannot demonstrate that improving dynamic balance or leg muscle power will necessarily increase kick speed.

Future studies should include larger and more diverse Taekwondo populations, use continuous measurements where appropriate, incorporate relevant confounding variables, and apply longitudinal or experimental designs. Such studies may provide stronger evidence regarding the contribution of physical capacities to momtong dollyo chagi performance.

### Author Contribution

Ni Wayan Dewi Adnyana Sri: Conceptualization, Data Curation, Formal Analysis, Investigation, Methodology, Writing Original Draft.  
I Putu Astrawan: Methodology, Supervision, Writing Review and Editing.  
I Made Dhita Prianthara: Supervision, Validation, Writing Review and Editing.  
I Ketut Arya Yoga Krismanthara: Methodology, Formal Analysis, Writing Review and Editing.  
All authors read and approved the final version of the manuscript.

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### Conflict of Interest Statement

The authors declare that they have no conflicts of interest related to this study.

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### Ethics Statement

This study received ethical approval from the Research Ethics Committee of Universitas Bali Internasional, with approval number 02.0631/UNBI/EC/II/2026. Written informed consent was obtained from all participants before their inclusion in the study.

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