

Flexibility and leg muscle power as correlates of dollyo chagi kicking performance in junior taekwondo athletes

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Abstract

Research Problem: Dollyo chagi (roundhouse kick) performance requires coordinated lower-limb movement, sufficient mobility, and rapid force production. However, the extent to which general flexibility and leg muscle power are associated with timed, accuracy-based kicking performance among junior Taekwondo athletes remains unclear. **Research Objective:** This study examined the individual and combined associations of flexibility and leg muscle power with dollyo chagi performance in junior Taekwondo athletes. **Methods:** A cross-sectional correlational study involved 30 athletes (16 males and 14 females) from one Taekwondo club, selected using saturated sampling. Flexibility was assessed using the sit-and-reach test, leg muscle power using a wall-based vertical-jump test and kicking performance using the number of accurate dollyo chagi kicks completed in 15 seconds. Pearson correlations and sex-stratified multiple linear regression analyses were conducted. **Results:** Among males, flexibility was not significantly correlated with kicking performance ($r = .372, p = .155$), whereas leg muscle power was positively correlated with performance ($r = .731, p = .001$). Among females, flexibility ($r = .680, p = .007$) and leg muscle power ($r = .717, p = .004$) were both positively correlated with performance. In the multiple regression models, leg muscle power remained independently associated with performance among males ($B = 0.370, \beta = .779, p = .005$) and females ($B = 0.401, \beta = .503, p = .032$). Flexibility was not independently associated with performance in either group (males: $p = .728$; females: $p = .061$). The models explained 53.8% and 65.3% of the variance in male and female performance, respectively. **Conclusion:** Leg muscle power showed a consistent positive association with timed dollyo chagi performance in both groups. The association involving flexibility was less consistent and was not statistically significant after adjustment for leg muscle power. These findings are preliminary and should be interpreted considering the small, single-club sample and the use of general field-based tests.

Keywords: Flexibility; Leg Muscle Power; Dollyo Chagi; Kicking Performance; Junior Taekwondo Athlete.

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INTRODUCTION

Taekwondo performance depends on technical proficiency, physical fitness, and the ability to execute attacks rapidly and accurately. *Dollyo chagi*, or the roundhouse kick, is a fundamental offensive technique involving coordinated lower-limb movements, movement velocity, postural control, and force generation (Falco et al., 2009; Gavagan & Sayers, 2017). Biomechanical research has identified foot velocity, lower-limb kinematics, execution distance, target height, and starting stance as factors associated with kicking performance (Estevan & Falco, 2013; Estevan et al., 2013; Huang et al., 2025). These findings indicate that successful kicking is multifactorial and cannot be explained by a single physical attribute. Flexibility may contribute to the range of motion needed to reach a target, whereas leg muscle

power may support rapid lower-limb acceleration. Both capacities are relevant to Taekwondo conditioning, but their associations with specific kicking outcomes require empirical examination (Bridge et al., 2014; Fachrezzy et al., 2024; Liu & He, 2022).

The relevance of physical fitness to kicking performance may depend on the specificity of both the physical test and the performance task. A sit-and-reach score, for example, provides a general indication of posterior-chain flexibility but does not directly measure hip range of motion during a roundhouse kick. Likewise, vertical-jump performance reflects general explosive lower-limb capacity rather than the force or velocity produced during a kick. Research on Taekwondo biomechanics and neuromuscular function further emphasizes the roles of movement coordination, technique, and athlete expertise in roundhouse-kick execution (Gavagan & Sayers, 2017; Sun et al., 2025; Yılmaz & Ateş, 2025). Accordingly, associations based on general field tests should be interpreted cautiously and should not be equated with direct measurements of kicking mechanics.

Although Taekwondo research has examined kicking biomechanics, physical conditioning, and sport-specific performance tests, evidence concerning the individual and combined associations of general flexibility and leg muscle power with timed, accuracy-based *dollyo chagi* performance in junior athletes remains limited. This question is practically relevant because coaches often use field-based fitness tests to monitor young athletes, even though such tests may not represent the technical demands of kicking directly. Therefore, this study aimed to examine the individual and combined associations of flexibility and leg muscle power with *dollyo chagi* performance, defined as the number of accurate kicks completed within 15 seconds, among junior Taekwondo athletes. It was hypothesized that both physical fitness variables would be positively associated with kicking performance. Because the study used a correlational design, the analyses were intended to identify associations and not causal effects.

METHOD

Research Design

This study employed a quantitative correlational design to examine the relationships between flexibility, leg muscle power, and *dollyo chagi* performance among junior Taekwondo athletes. Flexibility and leg muscle power were treated as predictor variables, while kicking performance was the outcome variable. The analysis examined both individual and combined associations. Because no experimental intervention was conducted, the findings were interpreted as associations rather than causal effects.

Participants

The sample comprised 30 junior athletes from Tiger Karigamas Taekwondo Club in Indralaya, Ogan Ilir Regency, South Sumatra, Indonesia (16 males and 14 females). All eligible junior athletes at the club were invited to participate, and all 30 were included through saturated sampling. Data were collected at the club from September 4 to 8, 2025. The age range and other participant characteristics should be reported only after they have been checked against the original participant records; these details are not consistently documented in the manuscript version available for revision.

Instruments

Sit-and-Reach Test

Flexibility was assessed using the sit-and-reach test. Each participant completed two attempts, and the farthest reach was recorded in centimetres. The sit-and-reach test is a field-based measure commonly used to estimate flexibility, but it does not directly assess hip mobility or the dynamic range of motion used during dollyo chagi. Research has reported acceptable reliability for sit-and-reach testing in some populations, while also identifying limitations in its criterion-related validity for estimating specific muscle-group flexibility (Mayorga-Vega et al., 2014; Kamaruddin et al., 2026). Accordingly, the present score was interpreted as sit-and-reach performance rather than as a direct measure of kicking-specific flexibility.

Vertical-Jump Test

Leg muscle power was assessed using a wall-based vertical-jump test. Participants first recorded their standing-reach height and then performed a maximal vertical jump to touch the highest possible point on the wall. Jump height was calculated as the difference between standing-reach height and jump-reach height. Two attempts were performed, and the higher score was retained. The resulting score was treated as an indicator of general explosive lower-limb performance. Although field-based vertical-jump tests are widely used, evidence concerning the reliability and validity of devices or protocols cannot automatically be transferred to the exact wall-based procedure used in this study (Comyns et al., 2023). The test should therefore not be interpreted as a direct measurement of kicking power.

Comyns et al. (2023) reported good reliability for several field-based devices measuring countermovement-jump height, although validity varied by device. These findings support field-based jump assessment but do not directly validate the exact wall-based protocol used in

this study. Accordingly, the score was interpreted as an indicator of explosive lower-limb performance, not as a direct measurement of kicking power.

Dollyo Chagi Kicking Test

Dollyo chagi performance was assessed using a kicking target (pyongyo), a stopwatch, and a recording sheet. Participants used their preferred or strongest kicking leg and completed as many accurate *dollyo chagi* kicks as possible within 15 seconds. Three trials were performed, and the highest number of accurate kicks was retained as the performance score. The manuscript does not provide sufficient detail about target height and distance, the operational criteria for an accurate kick, rest intervals, or the treatment of invalid attempts. These protocol details should be checked against the original study records and added before publication; they should not be reconstructed from assumption.

The Frequency Speed of Kick Test (FSKT) has been examined as a sport-specific measure of kicking frequency, with test-retest reliability reported for a 10-second protocol in male black-belt athletes (Santos et al., 2020). However, the present test used a 15-second duration and its own reported accuracy-based scoring. Therefore, the reliability and validity estimates for the published FSKT cannot be assumed to apply to the present protocol. The measurement properties of this 15-second test remain unestablished in the absence of protocol-specific reliability and validity data (Apollaro et al., 2024).

Procedure

Data were collected at Tiger Karigamas Taekwondo Club between September 4 and 8, 2025. Each participant completed the sit-and-reach, vertical-jump, and *dollyo chagi* tests, and scores were recorded on study forms. The highest of two attempts was retained for the sit-and-reach and vertical-jump tests, while the highest score from three 15-second kicking trials was used as the kicking-performance measure. Further procedural details, including warm-up, rest periods, target positioning, and scoring criteria, must be verified from the original records and reported to enable replication.

Data Analysis

Data were analysed using IBM SPSS Statistics version 27. Descriptive statistics (mean, standard deviation, minimum, and maximum) were calculated for each variable. Pearson product-moment correlations were used to examine the bivariate associations of flexibility and leg muscle power with *dollyo chagi* performance. Multiple linear regression analyses were then conducted separately for male and female athletes, with flexibility and leg muscle power

entered simultaneously as predictors. Statistical significance was set at $p < .05$. Given the small subgroup sizes, the regression estimates should be interpreted cautiously. The manuscript should also report the diagnostic checks performed for linearity, residual distribution, homoscedasticity, influential observations, and multicollinearity; these checks must be confirmed from the analysis output rather than assumed.

RESULT

Descriptive Statistics

The analysis included 30 junior taekwondo athletes, comprising 16 male and 14 female athletes. The original recorded measurements were used for the reanalysis: sit-and-reach distance for flexibility, vertical jump height for leg-muscle power, and the number of *dollyo chagi* kicks for kicking performance. Descriptive statistics for these variables are presented in Table 1.

Table 1. Descriptive statistics of the original measurement scores

Variable	Group	<i>n</i>	<i>M</i>	<i>SD</i>	Minimum	Maximum
Flexibility (cm)	Male	16	11.63	2.16	7	16
	Female	14	10.86	3.11	7	15
Leg-muscle power (cm)	Male	16	53.44	13.37	30	76
	Female	14	49.93	8.75	40	67
<i>Dollyo chagi</i> performance (kicks)	Male	16	32.75	6.35	22	44
	Female	14	28.50	6.98	19	40

As shown in Table 1, male athletes had a mean flexibility score of 11.63 cm and a mean vertical jump height of 53.44 cm. Their mean *dollyo chagi* performance was 32.75 kicks. Among female athletes, the corresponding means were 10.86 cm for flexibility, 49.93 cm for vertical jump height, and 28.50 kicks for *dollyo chagi* performance. These descriptive differences are not, by themselves, evidence of statistically significant differences between the sexes.

Bivariate Associations

Pearson correlation analyses were conducted separately for male and female athletes to examine the associations of flexibility and leg-muscle power with *dollyo chagi* performance. The results are presented in Table 2.

Table 2. Pearson correlations between physical fitness variables and *dollyo chagi* performance

Group	Predictor	<i>r</i>	<i>p</i>	Interpretation at $\alpha = .05$
Male	Flexibility	.372	.155	Not significant
Male	Leg-muscle power	.731	.001	Significant
Female	Flexibility	.680	.007	Significant
Female	Leg-muscle power	.717	.004	Significant

Among male athletes, flexibility was positively but not significantly associated with *dollyo chagi* performance ($r = .372, p = .155$). In contrast, leg-muscle power showed a strong positive association with kicking performance ($r = .731, p = .001$). Among female athletes, both flexibility ($r = .680, p = .007$) and leg-muscle power ($r = .717, p = .004$) were positively and significantly associated with *dollyo chagi* performance. Thus, the bivariate results differed by sex for flexibility, whereas leg-muscle power was significantly associated with kicking performance in both groups.

Multiple Regression Analysis

Multiple linear regression analyses were performed separately for male and female athletes to examine the combined association of flexibility and leg-muscle power with *dollyo chagi* performance. The original measurement scores were entered into the models. The model statistics and regression coefficients are presented in Table 3.

Table 3. Multiple regression analysis predicting *dollyo chagi* performance

Group	Predictor	<i>B</i>	<i>SE</i>	β	<i>t</i>	<i>p</i>
Male	Flexibility	-0.243	0.684	-.083	-0.356	.728
Male	Leg-muscle power	0.370	0.110	.779	3.355	.005
Female	Flexibility	0.963	0.461	.429	2.090	.061
Female	Leg-muscle power	0.401	0.164	.503	2.450	.032

For male athletes, the overall regression model was statistically significant, $F(2, 13) = 7.581, p = .007, R = .734, R^2 = .538, \text{adjusted } R^2 = .467$. The model therefore accounted for 53.8% of the observed variance in kicking performance. When both predictors were considered simultaneously, leg muscle power was positively associated with performance ($B = 0.370, SE = 0.110, \beta = .779, t = 3.355, p = .005$), whereas flexibility was not independently associated with performance ($B = -0.243, SE = 0.684, \beta = -.083, t = -0.356, p = .728$).

For female athletes, the overall regression model was statistically significant, $F(2, 11) = 10.328, p = .003, R = .808, R^2 = .653, \text{adjusted } R^2 = .589$, accounting for 65.3% of the observed variance in kicking performance. Leg muscle power was positively associated with performance after adjustment for flexibility ($B = 0.401, SE = 0.164, \beta = .503, t = 2.450, p = .032$). Flexibility did not reach statistical significance in the model ($B = 0.963, SE = 0.461, \beta = .429, t = 2.090, p = .061$).

Across both sex-specific models, leg muscle power was the only predictor that showed a statistically significant independent association with *dollyo chagi* performance. Flexibility was significantly correlated with performance among female athletes in the bivariate analysis, but it was not statistically significant after adjustment for leg muscle power. The regression models

indicate the proportion of variance accounted for within these samples; they do not establish that either physical attribute causes changes in kicking performance.

DISCUSSION

This study examined the individual and combined associations of flexibility and leg muscle power with timed, accuracy-based dollyo chagi performance among junior Taekwondo athletes. The main finding was that leg muscle power was positively associated with kicking performance in both male and female athletes. Flexibility was positively associated with performance in the female group but not in the male group. However, it was not independently associated with performance in either regression model. These findings indicate that the relationship between physical fitness and kicking performance varies depending on the fitness component and analytical approach. This relationship should be considered in relation to the technical, biomechanical, and neuromuscular demands of the roundhouse kick (Falco et al., 2009; Estevan et al., 2013; Huang et al., 2025).

The relationship between flexibility and kicking performance requires cautious interpretation. Flexibility was positively correlated with performance among female athletes ($r = .680, p = .007$), but not among male athletes ($r = .372, p = .155$). Furthermore, flexibility was not an independent predictor in either regression model (male: $p = .728$; female: $p = .061$). This reduction in statistical significance after adjustment may reflect shared variance with leg muscle power, limited statistical power, or unstable estimates due to the small subgroup sizes. However, the present data cannot determine which explanation is most likely. In addition, the sit-and-reach test does not directly measure hip range of motion or dynamic flexibility during dollyo chagi. Therefore, its results should be interpreted as a general indicator of flexibility rather than a specific measure of kicking mobility (Mayorga-Vega et al., 2014; Kamaruddin et al., 2026).

In contrast, leg muscle power showed a consistent positive association with kicking performance in both male ($r = .731, p = .001$) and female athletes ($r = .717, p = .004$). It also remained significant in the regression models for males ($p = .005$) and females ($p = .032$). These findings suggest that general lower-limb explosive performance is related to the ability to execute kicks rapidly. However, the vertical-jump test measures general jumping ability rather than the specific force, velocity, or segmental coordination involved in dollyo chagi. Kicking performance is also influenced by execution distance, target height, stance, and coordination between body segments (Falco et al., 2009; Estevan & Falco, 2013; Jung & Park, 2022). Thus, the present findings demonstrate an association between vertical-jump

performance and timed kicking scores, rather than a direct explanation of kicking biomechanics.

The outcome measure also needs to be considered. Counting accurate kicks within 15 seconds reflects both movement frequency and the ability to meet the accuracy criteria. However, it does not measure impact force, kick velocity, technical quality, or consistency across attempts. Taekwondo-specific assessments use different test durations and scoring procedures, so the reliability of one protocol cannot automatically be applied to another (Santos et al., 2020; Apollaro et al., 2024). The manuscript also needs to provide clearer information about target placement, accuracy criteria, rest intervals, and procedures for invalid attempts. Without these details, the reproducibility and measurement properties of the test remain uncertain.

These findings may help coaches monitor junior athletes using field-based assessments. In this sample, vertical-jump performance was associated with timed dollyo chagi performance in both male and female groups. Nevertheless, vertical-jump and sit-and-reach tests should not replace direct assessments of kicking technique. A more comprehensive monitoring approach should combine general fitness tests with standardized sport-specific assessments and technical evaluations. Future studies should also consider direct measurements of hip range of motion, kicking velocity, impact force, and lower-limb kinematics.

Several limitations should be considered. First, the cross-sectional correlational design does not establish causality. Therefore, it cannot be concluded that improving leg muscle power or flexibility will necessarily improve dollyo chagi performance. Longitudinal studies and controlled training interventions are needed to examine these effects. Second, the sample consisted of only 30 athletes from one club, including 16 males and 14 females. The small sex-specific samples relative to the number of regression predictors may result in unstable coefficients and imprecise estimates. Therefore, the findings should not be generalized to all junior Taekwondo athletes without further research involving larger and more diverse samples.

Third, the physical fitness tests were indirect measures of the capacities required for kicking. Sit-and-reach performance does not directly represent hip mobility during kicking, while vertical-jump height does not directly measure kicking power. The study also did not establish the protocol-specific reliability or validity of the 15-second accuracy-based kicking test. Incomplete procedural information further limits reproducibility. Fourth, the manuscript does not consistently report participants' age range or provide sufficient information about

training experience, competitive level, and injury status. These characteristics should be verified from the original records because they may influence physical fitness and technical performance. Finally, differences in statistical significance between the male and female groups do not necessarily indicate actual sex differences. A formal interaction analysis or direct between-group comparison is required to establish such differences.

Overall, leg muscle power showed a consistent association with timed dollyo chagi performance, whereas the relationship involving flexibility was less consistent. These findings should be considered preliminary because of the small single-club sample and the limitations of the measurement instruments. Further studies using validated sport-specific assessments, larger samples, and more complete participant information are needed to confirm these findings.

CONCLUSIONS

In this sample of 30 junior Taekwondo athletes, leg muscle power measured by a wall-based vertical-jump test was positively associated with *dollyo chagi* performance in both male and female groups and remained statistically significant in the sex-specific multiple regression models. Flexibility measured by the sit-and-reach test was positively associated with performance only in the female bivariate analysis and was not independently associated with performance in either regression model. These findings do not establish causal effects and should be interpreted cautiously because of the small sample, single-club recruitment, indirect field-based measures, and incomplete documentation of the kicking-test protocol. Coaches may use general fitness tests as supplementary monitoring information, but kicking proficiency should be evaluated directly using standardized sport-specific measures. Future research should recruit larger samples, verify participant characteristics, establish the reliability and validity of the 15-second kicking test, and include direct biomechanical assessments.

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