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ORIGINAL ARTICLE

Correlation of Degree between Grip Strength and Back Muscle Strength in Sports Education Students

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ABSTRACTS

Purpose	This research aimed to examine the degree and direction of the relationship between handgrip strength and back muscle strength among Physical Education students.
Materials and Methods	The study utilized a non-experimental quantitative design with a cross-sectional correlational approach. It involved 38 Physical Education students (mean age= 20.42 ± 0.72 years) who had previously undergone injury screening. Handgrip strength was measured using a handgrip dynamometer, while back muscle strength was assessed with a back dynamometer. Data analysis included normality and linearity tests, followed by Pearson product-moment correlation.
Result	The results revealed a positive and significant correlation between handgrip strength and back muscle strength ($r = 0.839$, 95% CI: 0.71–0.91, $p < 0.001$). Handgrip strength explained approximately 70.4% of the variance in back muscle strength, indicating substantial, but incomplete, shared variance with back muscle strength.
Conclusion	These findings suggest that while there is an association between grip strength and back muscle strength, handgrip strength may serve as a practical screening indicator, but not a standalone substitute for direct back strength assessment. Future research is recommended to include a larger sample, employ a longitudinal design, and incorporate additional muscle-strength variables to improve the generalizability of the findings.
Keywords	Handgrip dynamometer; Back dynamometer; Back muscle strength; Handgrip strength.

INTRODUCTION

A key element of physical fitness is muscle strength (Prieske et al., 2020) and is closely linked to musculoskeletal health, functional capacity, and quality of life across populations engaged in structured physical activity (Conde-Pip et al., 2024; Gürkan et al., 2025). Functional adaptations resulting from strength training have been shown to improve motor skills such as agility, coordination, and endurance, demonstrating the broad benefits of muscle strength beyond isolated force production (Wan et al., 2025; X. Wang et al., 2025). The relationship between physical activity and muscle strength further underscores the role of muscle strength capacity as a key determinant of overall health and fitness outcomes (Harmon et al., 2025). Furthermore, resistance and functional strength training interventions have been shown to mitigate age-related declines in functional capacity, underscoring the importance of muscle strength in long-term musculoskeletal health (Brogno, 2025). In addition to determining motor function, muscular force production is essential for maintaining proper posture, preventing injuries, and maintaining long-term metabolic health (Hunt, 2003).

Therefore, measuring muscle strength is an essential part of evaluating physical condition, both in clinical populations and in healthy, physically active individuals (Beaudart et al., 2019). Empirical evidence suggests that higher levels of muscle strength are associated with better health-related quality of life and functional performance, supporting the inclusion of strength assessments in comprehensive physical evaluations (Conde-Pip et al., 2024).

Among various methods for assessing muscle strength, handgrip strength (HGS) has been widely used as a practical indicator of general muscle strength. The popularity of HGS is supported by its ease of implementation, high reliability, relatively low cost, and empirical evidence demonstrating its association with various health outcomes, including functional capacity, nutritional status, morbidity, and mortality in diverse populations (Norman et al., 2011; A. Y. Wang et al., 2018). In clinical and epidemiological contexts, HGS is often used as an early indicator of health and physical performance when more complex muscle-strength measurements are unavailable (Quattrocchi et al., 2024). Longitudinal findings also indicate that low HGS is associated with an increased risk of chronic non-communicable diseases, decreased muscle endurance, and unfavorable changes in body composition (Crislayne et al., 2025).

However, the assumption that HGS can represent overall body muscle strength remains controversial. Empirical evidence suggests that the relationship between HGS and other muscle strength—including trunk and back muscles—is inconsistent and is strongly influenced by measurement method, sample characteristics, and the context of the individual's physical activity. A recent systematic review by Szaflik et al. (2025) reported that correlations between HGS and muscle moment strength in the trunk and other extremities ranged from low to high, depending on the population and measurement approach used. This variability underscores the need for caution when using HGS as the sole indicator of body strength.

These inconsistencies in findings are also reflected in specific population-based studies. Research on cricket players has shown a significant correlation between HGS and back muscle strength in adults. However, no such relationship was found among adolescents, indicating that age and physical developmental status influence the degree of association among muscle strength variables (Singla & EjazHussain, 2018). Furthermore, evidence from the clinical and public health domains suggests that trunk muscle strength is an important indicator of musculoskeletal and metabolic health, relatively independent of handgrip strength (Dixit et al., 2023; Jeon et al., 2021). These findings further emphasize that generalizing HGS as a universal proxy for muscle strength remains context-dependent.

To date, research on the relationship between handgrip strength (HGS) and back muscle strength has predominantly focused on clinical populations, older adults, or elite athletes, leaving physically active yet non-specialized groups, such as sport education students, underexplored. Addressing this gap, the present study targets this intermediate population, which is routinely involved in strength assessment for educational, screening, and research purposes. This study therefore provides novel population-specific evidence on the validity of HGS as a proxy for back

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muscle strength, while offering a methodological contribution by evaluating the appropriateness of a simple, widely accessible measure within a non-clinical, educational context.

Specifically, this study examines the extent to which HGS represents back muscle strength in an active, non-elite population. The findings are expected to clarify the methodological use of HGS in strength assessment, support evidence-based practices in physical education and sport science, and reduce the risk of overgeneralization in interpreting HGS as an indicator of overall muscular strength.

Therefore, clarifying the degree of correlation between handgrip strength and back muscle strength in physical education students is both scientifically and practically relevant. This study aims to provide context-specific empirical evidence regarding the extent to which the HGS can represent back muscle strength in an active, but non-elite, population. The findings of this study are expected to provide methodological clarity regarding the use of the HGS as a strength assessment tool, support evidence-based evaluation practices in physical education and sport science, and prevent overgeneralization in interpreting handgrip strength measurement results.

METHODS

Study Participants

The study involved undergraduate Physical Education students enrolled in a sport science program as the target population. A total sampling approach was employed, in which all eligible students who met the inclusion criteria during the data collection period were invited to participate. The inclusion criteria were: (1) actively enrolled as a Physical Education student, (2) physically active, and (3) free from musculoskeletal injuries at the time of testing, as determined through a preliminary injury screening. Participants with a history of back injury were excluded to avoid potential bias in back muscle strength measurement. All participants were informed about the study procedures and provided informed consent prior to participation. Participants were informed of their right to withdraw at any time without penalty.

Initially, 39 students participated in the study; however, one participant was excluded due to a reported history of back injury, resulting in a final sample size of 38 students (27 men and 11 women) with an average age and distribution of variation (20.42 ± 0.72). Back Dynamometer has been shown to be a valid and reliable instrument for assessing back muscle strength (Coldwells et al., 2007). Then, handgrip strength was measured using a Grip Strength Dynamometer, as has been widely used in previous studies to evaluate muscle strength capacity in several populations (Amaral et al., 2012; Gatt et al., 2018; Güçlüöver et al., 2015)

Study Organization

This study used a non-experimental, quantitative, cross-sectional correlational design, in which all data were collected at a single point in time (Creswell, 2009). This design aimed to examine the extent and direction of the relationship between handgrip strength and back muscle strength without manipulating the research variables, so it was not intended to draw causal conclusions.

Statistical Analysis

Data were analyzed using SPSS version 23. Prior to the main analysis, statistical assumptions were examined, including normality (Shapiro–Wilk test), linearity (ANOVA for linearity and scatterplot inspection), outliers (standardized residuals), and homoscedasticity (scatterplot of standardized residuals versus predicted values). After these assumptions were satisfied, the Pearson product-moment correlation coefficient was used to examine the relationship between handgrip strength and back muscle strength, in accordance with the characteristics of interval/ratio data and the objectives of correlational analysis (Kim, 2018; Mukaka, 2012). The coefficient of determination (R^2) was calculated to estimate the proportion of variance explained. In addition, the 95% confidence interval for the correlation coefficient was reported. Statistical significance was set at $p < 0.05$.

RESULT

Table 1. Normality test

	Shapiro-Wilk		
	Statistic	**df**	**Sig.**
Back Muscle Strength	.950	38	.089
Handgrip Strength	.981	38	.763

Statistical assumption tests were performed prior to the correlation analysis. The Shapiro–Wilk normality test showed that the back muscle strength (W = 0.950; p = 0.089) and handgrip strength (W = 0.981; p = 0.763) data were normally distributed (p > 0.05), thus meeting the requirements for parametric analysis (Table 1).

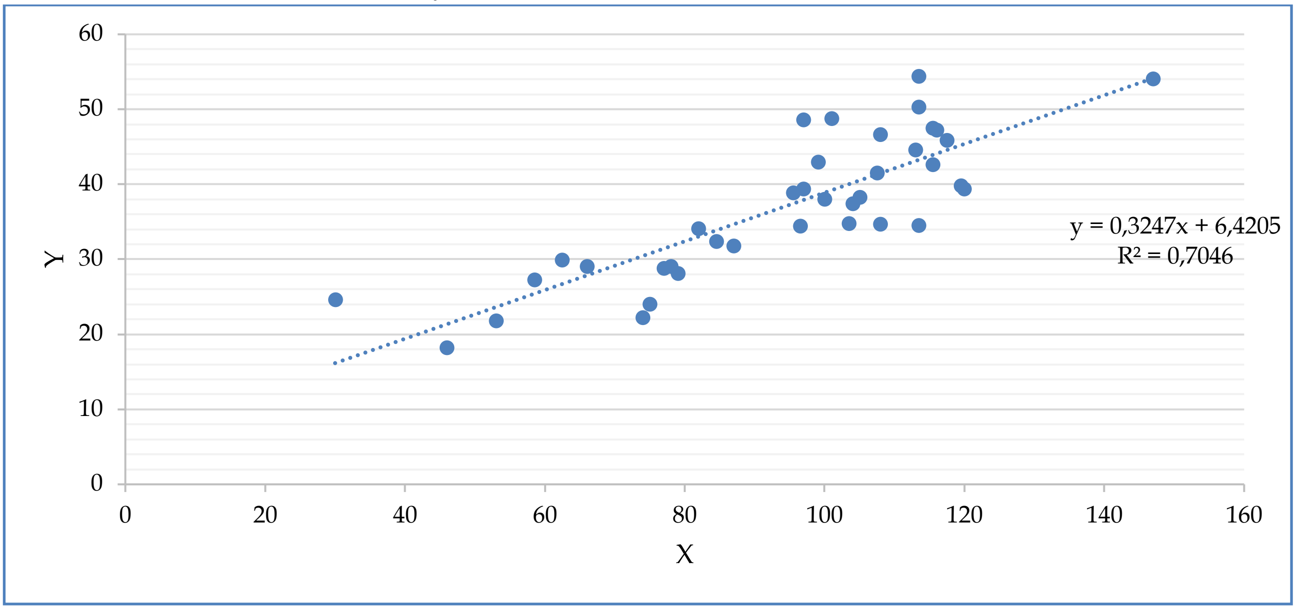

Figure 1. Results of the linearity test of variable X (Hand grip strength) and variable Y (Back muscle strength)

Next, the linearity between handgrip strength and back muscle strength was examined using a scatterplot. Figure 1 shows a trend toward a positive linear relationship, despite the relatively broad distribution of the data. The linear regression line has the equation $y = 0.3247x + 6.4205$ with a coefficient of determination $R^2 = 0.7046$, indicating that approximately 70,4% of the variation in back muscle strength can be explained by handgrip strength.

Table 2. Linearity test (anova for linearity)

			Sum of Squares	df	Mean Square	F	Sig.
Backmuscle * handgrip	Between Groups	(Combined)	21214.683	35	606.134	3.603	.241
		Linearity	15185.609	1	15185.609	90.256	.011
		Deviation from Linearity	6029.074	34	177.326	1.054	.603
	Within Groups		336.500	2	168.250		
	Total		21551.183	37			

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Based on Table 2, linearity between handgrip strength and back muscle strength was further examined using ANOVA for linearity. The results indicated a significant linear relationship (p = 0.011) and no significant deviation from linearity (p = 0.603), confirming that the assumption of linearity was met.

Table 3. Data checked for outliers

Residuals Statistics[a]					
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	53.3828	131.9413	94.1868	20.25887	38
Residual	-37.27161	24.74417	.00000	13.11650	38
Std. Predicted Value	-2.014	1.864	.000	1.000	38
Std. Residual	-2.803	1.861	.000	.986	38

a. Dependent Variable: BACKMUSCLE

Based on Table 3, Outliers were assessed using standardized residuals. The results showed that all values were within the acceptable range (−2.803 to 1.861), indicating that no significant outliers were present in the dataset.

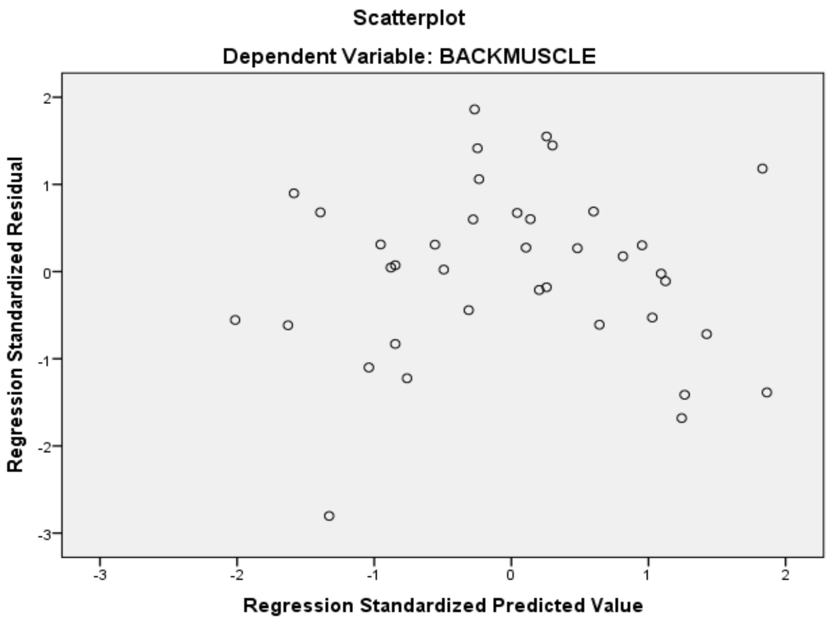

Figure 2. Homoscedasticity assumption checked

Based on fig 2, Homoscedasticity was assessed using a scatterplot of standardized residuals versus standardized predicted values. The plot showed a random distribution of points without any discernible pattern, indicating that the assumption of constant variance was met.

Table 4. Correlation test

		Back Muscle Strength	Handgrip Strength
Back Muscle Strength	Pearson Correlation	1	.839
	Sig. (2-tailed)		.000
	N	38	38
Handgrip Strength	Pearson Correlation	.839	1
	Sig. (2-tailed)	.000	
	N	38	38

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The results of the analysis showed a significant positive relationship between handgrip strength and back muscle strength ($r = 0.839$; $p < 0.001$; $n = 38$), as presented in Table 4. The correlation value indicates that an increase in handgrip strength tends to be followed by an increase in back muscle strength in Physical Education students. The 95% confidence interval for the Pearson correlation coefficient. An interpretation of effect size, indicating that the observed correlation ($r = 0.839$) represents a large effect size, based on established conventions. The Pearson correlation analysis revealed a strong positive relationship between handgrip strength and back muscle strength ($r = 0.839$, $p < 0.001$; $n = 38$). The 95% confidence interval ranged from 0.71 to 0.91, indicating a strong and statistically reliable association.

DISCUSSION

The results of this study indicate a significant positive correlation between handgrip strength (HGS) and back muscle strength in Physical Education students. This research contributes to the ongoing discussion about handgrip strength as an overall indicator of muscle strength by demonstrating a strong correlation specifically with back muscle strength, particularly in a demographic that has been rarely studied before.

The findings confirm that handgrip strength reflects a broader neuromuscular capacity rather than just local upper-limb strength. This aligns with previous research that shows handgrip strength is moderately to strongly correlated with the strength of major muscle groups, including trunk and lower body muscles, especially in physically active individuals (Dixit et al., 2023; Jeon et al., 2021; Wind et al., 2010).

From a physiological standpoint, the observed correlation can be attributed to the interconnected nature of muscle strength development. Grip strength is influenced not only by the forearm muscles but also by factors such as neural drive, central motor unit recruitment, and overall muscle mass, all of which contribute to trunk and back muscle force (Bohannon, 2019; Hunt, 2003). For Physical Education students, who regularly engage in weight training, skill-based activities, and weight-bearing movements, neuromuscular adaptations tend to occur across muscle groups rather than in isolation, thus enhancing the relationship between peripheral and axial muscle strengths.

These findings are consistent with evidence from adult athletes, which shows a strong relationship between handgrip strength and back strength, but this correlation is less pronounced in younger or less trained individuals (Singla & EjazHussain, 2018). This distinction is important as it suggests that training status and neuromuscular maturity are critical factors in this relationship. Physical Education students represent a group in transition between adolescents and elite athletes, characterized by relatively uniform physical exposure, which may improve the correlation between various strength indicators.

Although handgrip strength is becoming more widely accepted as a general predictor of muscle strength and health (García-hermoso et al., 2018; Leong et al., 2015; Ruiz et al., 2008), care should be taken when considering HGS as the only measure of total strength. Studies that compare HGS with knee extensor strength or muscle torque have shown low to moderate agreement at the individual level, particularly across different ages and health statuses (Szaflik et al., 2025; Yeung et al., 2020). These differences are especially pronounced in clinical or elderly populations and may be less relevant for physically active young adults, such as the participants in this study.

The moderate to strong correlations observed through Pearson product-moment analysis reinforce the value of HGS as a practical proxy for back muscle strength at the population level among Physical Education students. Beyond its implications for performance, this relationship is

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significant for health monitoring. Extensive epidemiological research shows that muscle strength, often measured through grip strength, is inversely associated with all-cause mortality, cardiovascular disease, functional decline, and metabolic disorders (Celis-morales et al., 2018; Vaishya et al., 2024; Volaklis et al., 2015). In particular, trunk and back muscle strength are critical for postural control, injury prevention, and maintaining functional independence (Beaudart et al., 2019; Hunt, 2003). Therefore, the correlation found in this study supports the use of grip dynamometry as a quick screening tool in educational and exercise science settings.

However, these findings should not imply that grip strength can completely substitute for comprehensive strength assessments. Research into muscle endurance and fatigue indicates that grip performance does not always correlate with trunk or lower limb endurance capacity (White et al., 2013). Additionally, factors such as BMI and central adiposity can influence grip strength independently of actual muscle quality (Mahapatra & Karri, 2025), highlighting the need for careful contextual interpretation.

For Physical Education programs, these findings have practical implications. Grip strength testing is a cost-effective and quick method to gain early insights into a student's strength status, especially when testing resources or time are limited. When combined with targeted trunk strength assessments, HGS can help identify students at risk for low musculoskeletal fitness, suboptimal performance, or future health issues.

In conclusion, this study adds to the ongoing discussion regarding handgrip strength as an overall indicator of muscle strength by providing evidence of a strong correlation between handgrip strength and back muscle strength in Physical Education students. These findings suggest that handgrip strength may serve as a practical proxy for back muscle strength at the population level within this specific group. However, it should not be considered a standalone measure, and comprehensive assessment of muscle strength remains necessary.

CONCLUSION

This study found a strong and significant positive relationship between handgrip strength and back muscle strength among Physical Education students. Handgrip strength explained approximately 70% of the variance in back muscle strength, indicating substantial shared variance between the two measures. Nevertheless, handgrip strength does not fully capture all aspects of trunk strength and should be used as a supplementary rather than standalone indicator. Future studies should involve larger and more diverse samples, include additional strength variables, and employ longitudinal or experimental designs.

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CONFLICT OF INTEREST

The authors declare no conflict of interest regarding this research.

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