Original Article

Impact of Physical Education Curriculum on Muscular Strength of University Students

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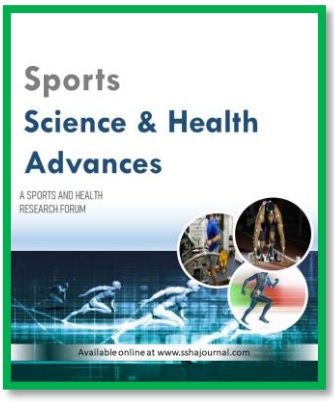

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Abstract

Purpose: Physical education is a subject which improve the overall physical activity and strength of the students in school and college settings. The present study aimed to explore impact of physical education curriculum on the muscular strength in terms of hand grip strength of university students. **Material and Methods**: A total of 100 university students, both male and female, participated in this study, representing multiple academic departments. Each participant's physical characteristics, including height, weight, and BMI, were recorded. Hand grip strength was measured using right hand grip strength (RHGS), left hand grip strength (LHGS), and average hand grip strength (AHGS). Statistical analysis was conducted to compare physical parameters across departments and to assess correlations between physical characteristics and grip strength. Additionally, network analysis was used to visualize the interrelationships among variables. **Results**: The comparison of baseline characteristics between students in Physical Education and other departments showed no significant differences in height, weight, or BMI, indicating that physical characteristics were similar across groups. However, correlation analysis revealed a strong positive association between grip strength and certain physical parameters, particularly weight and height. Network analysis highlighted that, for both male and female participants, weight was significantly correlated with hand grip strength, while height showed moderate associations. These findings suggest that students with higher weight and greater height tend to have stronger hand grip strength. **Conclusion**: This study demonstrates that physical parameters, especially weight and height, are important determinants of hand grip strength. These factors should be considered when assessing grip strength and designing training programs aimed at its improvement. For practitioners and educators in fields related to physical education and sports science, incorporating weight and height into grip strength evaluation and training can enhance the accuracy and effectiveness of program outcomes. This insight emphasizes the importance of a holistic approach to grip strength development, integrating physical parameters to support optimal strength performance.

Keywords: Physical Education, Hand Grip Strength, Public Health, Muscular Strength

Introduction

Muscular strength refers to the maximum force that the body can generate, and it is influenced by a combination of morphological and neural factors (Smith et al., 2024). These factors include the muscle's cross-sectional area, its architecture, musculoskeletal stiffness, and neural components such as motor unit recruitment, rate coding, motor unit synchronization, and neuromuscular inhibition (Ramos et al., 2023). In terms of general health, studies have shown that low levels of muscular strength are associated with a higher risk of premature death, independent of other factors like body mass index (BMI) and blood pressure (Butovskaya et al., 2022; Meisel et al., 2023). One key measurement of muscular strength is hand grip strength, which is influenced by the overall structure of the human body (Little et al., 2024). Hand grip strength has been shown to correlate positively with various aspects of body composition and anthropometric measures, such as BMI, height, and weight (Busta et al., 2022; Rahma & Sharma, 2023). Regular physical activity has a significant impact on enhancing muscular strength, including grip strength (Confortin et al., 2022; Mausehund et al., 2022; Yuan et al., 2022; Fenta & Mola, 2023). Hand grip strength can be measured using a digital dynamometer, which quantifies the static force a person can exert with their hand (Bellón et al., 2024; Garcia et al., 2022; Hong et al., 2022; Kwon et al., 2024). This force is typically recorded in kilograms or pounds (DeHondt et al., 2023). Research has found that grip strength is not only an indicator of muscular strength but is also predictive of other health outcomes (Chaput et al., 2023; Wu et al., 2022). For instance, normal grip strength is associated with higher bone mineral density, and some researchers suggest that grip strength could serve as a screening tool for women at risk of osteoporosis (Belhaidas et al., 2023; Garcia-Hermoso et al., 2021; Ozaki et al., 2021).

In the context of the physical education curriculum, regular involvement in physical activities, especially those promoting resistance training and overall fitness, can enhance muscular strength, including hand grip strength (Lichtenstein et al., 2023). Thus, a well-structured physical education program is crucial for university students to build and maintain muscular strength, contributing to both their immediate fitness levels and long-term health outcomes (Jeon et al., 2021; Nakanishi et al., 2024; Mola & Bayeta, 2020). The physical well-being of university students is often overlooked, despite the significant pressures of academic life that can lead to sedentary behavior and poor physical health. Integrating a structured physical education curriculum is essential for promoting not only academic success but also lifelong health habits. Such programs are designed to enhance various components of fitness, including muscular strength, which plays a pivotal role in physical health, injury prevention, and daily functioning.

At Chaudhary Ranbir Singh University (CRSU), the Department of Physical Education offers both undergraduate (B.P.Ed) and postgraduate (M.P.Ed) programs, designed to foster the physical, mental, and social development of students. The curriculum is structured to provide students with a comprehensive understanding of physical education and its role in promoting health and fitness. The daily schedule for students involves two practical sessions, one in the morning and one in the evening, each lasting for one hour. During these sessions, students participate in a range of physical activities, including eight different games and athletic events. These sessions are designed to improve various physical attributes, including muscular strength, endurance, agility, and overall fitness.

In total, students engage in approximately 120 minutes of physical activity every day (Kurihara et al., 2021; Lbban et al., 2024; Tsuburai et al., 2022; Xu et al., 2023). The integration of both theoretical and practical components in the curriculum ensures that students not only develop the physical skills necessary for athletic performance but also gain a deep understanding of the science behind exercise, training methods, and health promotion (Seaton et al., 2023). This curriculum reflects CRSU's commitment to producing well-rounded graduates equipped with the knowledge and skills to promote physical education and well-being in various professional contexts (Abe et al., 2022). By combining structured physical training with academic study, the program aims to enhance the overall fitness and health of its students, laying a foundation for lifelong physical activity and well-being (Siniarska et al., 2021).

This study focuses on evaluating the impact of a physical education curriculum on the muscular strength of university students. By assessing the effectiveness of structured physical activities within an academic environment, this research seeks to contribute to the understanding of how educational programs can be optimized to improve student health outcomes. Given the importance of muscular strength as both a marker of fitness and a predictor of future health risks, this study aims to demonstrate the broader implications of physical education curricula in fostering healthier lifestyles among young adults.

Material and Methods

Table 1 Participants Characteristics

Departments	Gender	N	Age	Ht.	Wt.	BMI	RHGS	LHGS	AHGS
Psychology	Male	1	20.00	187.96	90.00	25.47	62.20	64.40	63.30
	Female	0							
BBA	Male	3	20.33	171.03	55.33	18.95	42.00	38.50	41.15
	Female	0							
Communication	Male	1	21.00	154.94	60.00	24.99	40.20	40.70	40.45
	Female	0							
Geography	Male	1	21.00	180.34	70.00	21.52	25.60	27.60	26.60
	Female	0							
Hindi	Male	2	23.00	158.75	62.50	24.89	50.90	51.10	51.00
	Female	4	22.25	164.47	51.00	18.84	27.45	25.60	26.45
Law	Male	2	22.00	182.88	68.50	20.15	47.10	36.80	41.95
	Female	0							
English	Male	1	24.00	170.18	67.00	23.13	43.20	48.10	45.65
	Female	0							
History	Male	2	22.50	175.26	72.00	23.29	55.10	50.10	52.60
	Female	0							
Public Add.	Male	1	23.00	172.72	72.00	24.13	53.20	53.60	53.40
	Female	0							
Sociology	Male	4	21.70	172.08	79.50	27.34	58.60	55.80	57.40
	Female	2	21.00	158.75	41.50	16.48	21.95	21.65	21.80
Yoga	Male	1	20.00	180.34	76.00	23.37	57.80	58.80	58.30
	Female	0							
Commerce	Male	1	21.00	182.88	72.00	21.53	56.20	54.80	55.50
	Female	0							
Math	Male	0							
	Female	6	23.00	159.17	46.50	18.40	26.45	25.60	25.98
MBA	Male	0							
	Female	4	21.00	160.02	50.25	19.60	25.40	22.70	24.05
Library Science	Male	1	23.00	154.94	76.00	31.66	61.10	54.60	57.85
	Female	0							
Physical Education	Male	25	22.36	170.48	67.56	23.38	50.30	46.80	48.50
	Female	25	22.32	162.05	54.04	20.52	30.00	26.70	28.75
Physics	Male	0							
	Female	6	21.16	158.75	44.83	17.75	23.15	18.55	20.85
Political Science	Male	4	22.00	169.55	68.00	23.89	50.90	40.20	45.43
	Female	3	21.33	157.48	59.67	24.02	26.80	27.90	27.35

Ht. = Height; Wt. = Weight; BMI = Body Mass Index; RHGS = Right Hand Grip Strength; LHGS = Left Hand Grip Strength, `AHGS = Average Hand Grip Strength

Participants

The participants in this study consisted of 100 university students from various academic departments, including Psychology, Business Administration (BBA),

Communication, Geography, Hindi, Law, English, History, Public Administration, Sociology, Yoga, Commerce, Mathematics, Library Science, Physical Education, Physics, and Political Science. These students were a mix of males and females, with a total of 50 male and 50 female participants, providing a balanced gender representation across the sample. The age of participants ranged from 20 to 24 years, ensuring a relatively homogenous age group of young adults, which helped to minimize age-related differences in physical strength characteristics. Each participant's height, weight, and body mass index (BMI) were measured to provide baseline physical characteristics for the study. Hand grip strength was assessed for both the right and left hands, and an average hand grip strength (AHGS) value was calculated for each participant.

Measuring of hand grip strength

Grip strength was measured using a Camery digital dynamometer (model no: 14192-709E). Participants were instructed to stand in an upright position with their arms extended downward. Grip strength for both hands was measured, with each participant given three attempts, and the maximum grip strength was recorded. The average of both hands' grip strength was used for analysis, with the results expressed in kilograms.

Results

The table 1 provides an overview of participant characteristics across various departments, separated by gender. Key metrics include age, height (Ht.), weight (Wt.), body mass index (BMI), right-hand grip strength (RHGS), left-hand grip strength (LHGS), and average hand grip strength (AHGS). For males, sample sizes vary, with Physical Education having the largest male representation (N=25) and high AHGS scores averaging 48.50. In contrast, departments such as Psychology and Yoga have only one male participant each. Female participants are notably present in departments like Physical Education (N=25) and Math (N=6). The female Physical Education group shows an average AHGS of 28.75, indicating stronger hand grip compared to other female-dominated departments, where AHGS values generally fall below 30.00.

Table 2 Comparison between physical education and other students in their physical parameters to ensure the baseline characteristics of the participants

		Sum of Squares	df	Mean Square	F	Sig.
Height	Between Groups	4.129	1	4.129	.045	.832
	Within Groups	8947.853	98	91.305		
	Total	8951.982	99			
weight	Between Groups	64.000	1	64.000	.405	.526
	Within Groups	15504.000	98	158.204		
	Total	15568.000	99			
BMI	Between Groups	7.608	1	7.608	.501	.481
	Within Groups	1488.377	98	15.188		
	Total	1495.985	99			

Table 2 presents a comparison between Physical Education students and students from other departments in terms of their physical characteristics—height, weight, and BMI. The F and Sig. values indicate that there are no statistically significant differences between the two groups for any of these parameters. For instance, the F values for height (0.045), weight (0.405), and BMI (0.501) all have Sig. values above the threshold of 0.05, indicating similarity in these baseline characteristics. This is important as hand grip strength, often correlated with physical parameters like height, weight, and BMI, can be interpreted without the confounding effect of significant baseline differences in these physical characteristics.

Table 3 Comparison of mean scores between physical education and other students in the average hand grip strength

Gender	Departments	N	Mean	SD	F	Sig
Male	Physical Education	25	48.32	8.57	.019	.890
	Other	25	48.68	9.72		
Female	Physical Education	25	29.51	5.18	8.746	.005
	Other	25	25.06	5.46		

Level of significance: 0.05

Table 3 specifically compares the average hand grip strength (AHGS) between Physical Education students and students from other departments, separated by gender. Among male students, the mean AHGS for Physical Education students (48.32) is very similar to that of students from other departments (48.68), with an F value of 0.019 and a Sig. value of 0.890, confirming no significant difference. However, a notable difference is observed among female students, with Physical Education students showing a significantly higher mean AHGS (29.51) compared to their counterparts from other departments (25.06), with an F value of 8.746 and a Sig. of 0.005. This significant difference in female hand grip strength could reflect the impact of physical training in the Physical Education department, as well as an indication of fitness levels related to physical curriculum involvement.

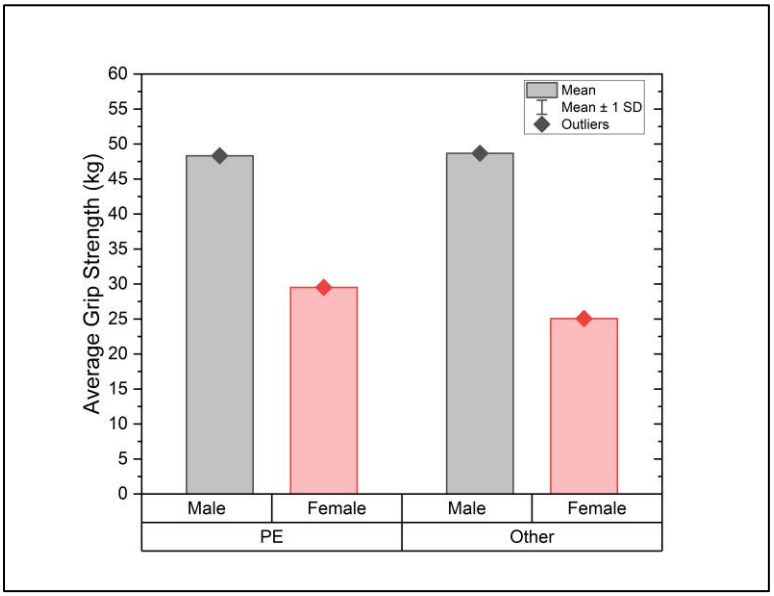

Figure 1 Distribution of Mean Score of average hand grip strength of male and female students from physical education and other departments

Discussion

The results of this study provide insights into the physical characteristics and hand grip strength differences between Physical Education students and their peers from other departments. Table 2 reveals that there are no statistically significant differences in baseline physical characteristics—namely height, weight, and BMI—between the two groups. The lack of significant differences, indicated by the high p-values for height (Sig. = .832), weight (Sig. = .526), and BMI (Sig. = .481), suggests that students from both Physical Education and non-Physical Education departments share similar physical profiles. This similarity in baseline characteristics is crucial, as it implies that any differences observed in hand grip strength are likely attributable to factors beyond basic physical characteristics, such as variations in physical training and activity levels. Given that hand grip strength can

be influenced by body composition and overall muscular fitness, the comparable physical characteristics across groups strengthen the validity of examining hand grip strength independently as a potential indicator of fitness differences linked to specific curriculum demands.

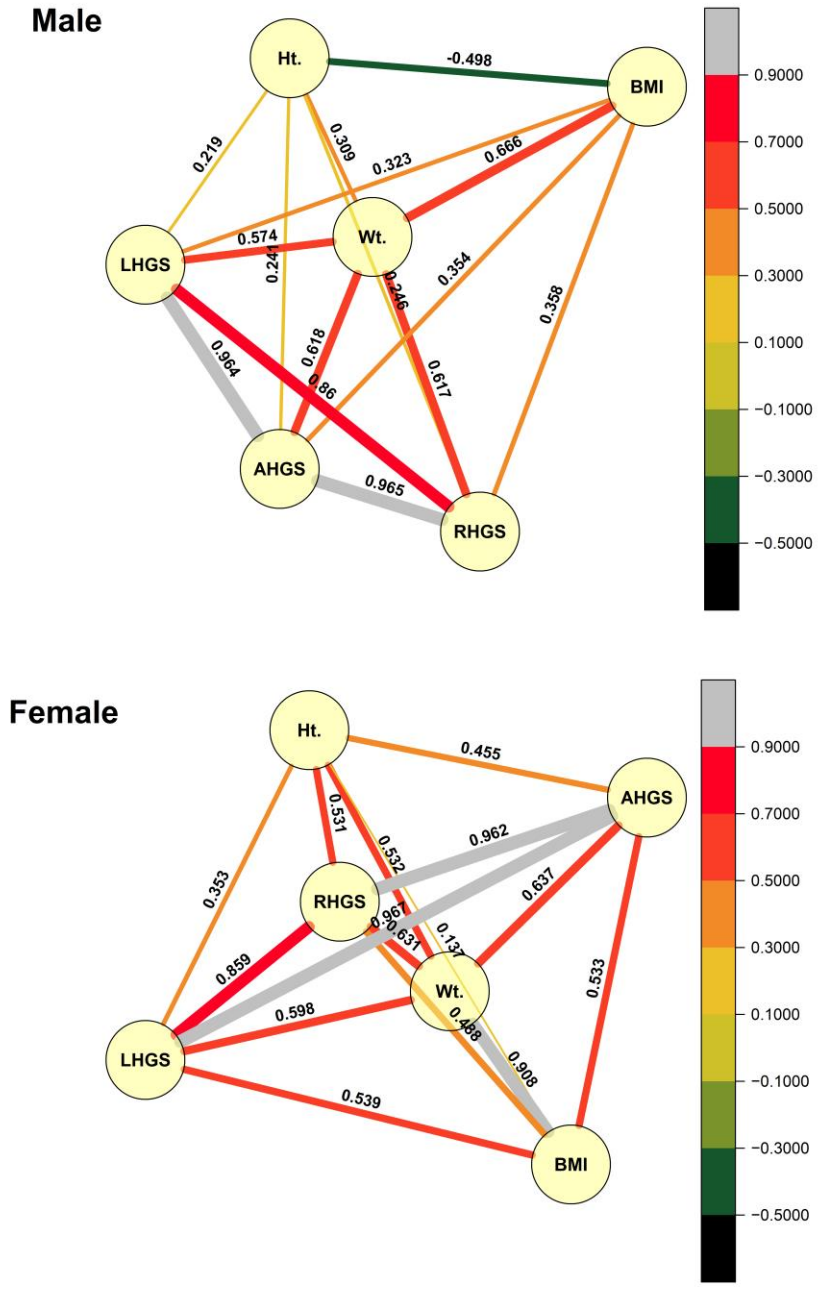

Figure 2 Network plot of correlation matrix among the interested variable

In examining hand grip strength (Table 3), a clear distinction emerges between the Physical Education and non-Physical Education groups, particularly among female students. For male participants, the average hand grip strength is nearly identical across groups, with Physical Education students showing a mean AHGS of 48.32 and other students showing 48.68, resulting in a non-significant difference (Sig. = .890). This similarity may indicate that, among males, external factors beyond academic department (de Souza et al., 2022; Laurson et al., 2022), such as personal fitness habits or varying participation in recreational physical activities, play a role in leveling hand grip strength (Homolak et al., 2022; Lopez-Jaramillo et al., 2022; Reza et al., 2024). However, a significant difference is observed among female students, where Physical Education students exhibit a higher mean AHGS (29.51) compared to non-Physical Education students (25.06), with a p-value of 0.005. This result suggests that structured physical education programs, likely involving regular training and strength-based exercises, contribute to greater hand grip strength among female students (Noji et al., 2024; Takahashi et al., 2024; Triana-Reina et al., 2022). It highlights the impact of targeted physical training on muscle strength, especially in populations who may generally have less engagement in strength training outside of structured programs. Thus, these findings underscore the role of Physical Education curricula in enhancing muscular strength, especially among female students, and suggest that the regular physical activities incorporated in these programs foster measurable fitness benefits that might not be as evident in the male cohort, potentially due to higher baseline engagement in physical activity across genders.

Figure 2 illustrates the network of correlations between physical parameters (height, weight, and BMI) and hand grip strength measures (RHGS, LHGS, and AHGS) for both male and female participants. The results emphasize that hand grip strength is not an isolated measure; rather, it is closely linked to body dimensions, particularly weight and height (Noji et al., 2024).

For males, there is a strong positive correlation between both right- and left-hand grip strengths with the average hand grip strength (above 0.9), suggesting that improvements in one aspect of grip strength likely translate to overall hand strength gains (Abe et al., 2022). Additionally, weight shows a moderate positive correlation with both BMI (0.666) and grip strength measures (e.g., RHGS at 0.617 and AHGS at 0.965). Height, meanwhile, has a slight positive correlation with hand grip strength (e.g., 0.617 with RHGS) but a negative correlation with BMI (-0.498), indicating that while taller individuals may not necessarily have higher BMI, their height may still contribute positively to grip strength (Siniarska et al., 2021). In females, similar relationships are seen, with weight and BMI showing strong positive correlations with hand grip strength (e.g., weight and AHGS at 0.637). Height also demonstrates moderate correlations with RHGS (0.532) and AHGS (0.455), suggesting that taller and heavier individuals may have an advantage in hand grip strength, likely due to greater muscle mass and leverage (Mosse, 2020).

These findings suggest that when working to improve or analyze hand grip strength, it is essential to also consider physical parameters like weight and height. Variations in these characteristics significantly influence grip strength, highlighting the need for a comprehensive approach in training or assessment. Therefore, interventions aimed at enhancing hand grip strength should take these physical factors into account, as improvements in body composition and overall fitness may lead to more substantial gains in grip strength.

Conclusion

In conclusion, this study highlights that while baseline physical characteristics such as height, weight, and BMI are similar between Physical Education students and their peers, significant differences in hand grip strength are observed, particularly among female students. This suggests that the structured physical training in Physical Education programs enhances muscular strength, especially for female students who may otherwise have lower engagement in strength-based activities. These findings emphasize the positive impact of

physical education on strength development, demonstrating its importance in promoting fitness and physical health within academic settings.

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