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Predicting Yoga Performance: A Multiple Regression Analysis of Physical Fitness Variables

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ABSTRACT

This study examines the correlation between physical fitness variables and yogic performance in 25 young yogasana players from Delhi-NCR. Utilizing Pearson correlation and multiple linear regression analyses, the study identifies flexibility as a significant predictor of yogic performance, explaining 38.7% of its variance. Results indicate a strong positive correlation between flexibility and yogic performance ($r = .622$, $p < 0.01$), while sit-ups, push-ups, and balance show non-significant correlations. The findings highlight the critical role of flexibility in enhancing yoga performance, suggesting its incorporation into training regimens for improved outcomes. Future research should explore additional variables influencing yogic performance.

Keywords: *Yoga, Yogasana, Physical Fitness, Flexibility, Performance Prediction, Multiple Regression Analysis, Pearson Correlation, Competitive Sport*

1. INTRODUCTION

"योग: कर्मसु कौशलम्"

"Getting the mastery over the skill or the activity, which we are performing in our life."

Yoga integrates scientific principles with fitness, enhancing physical, mental, emotional, psychic, and spiritual health. The Sanskrit term "yuj" means "to join," and "yoga" translates to "unity" or "oneness" in English (Iyengar, 2001). Yoga fosters holistic health without significant bodily bending, promoting the comprehensive growth and nourishment of the organism (Saraswati, 1981). It is the most cost-effective and scientifically proven method to maintain health, simultaneously improving mental and physical wellness (Desikachar, 1995). Daily yoga routines cultivate optimism, leading some to term yoga a "fundamentally subjective science" due to its interconnected spiritual, mental, and bodily components (Feuerstein, 1998). Yoga encourages mental and sensory self-mastery, serenity, and tranquility, with universal benefits irrespective of religious or mystical connotations (Eliade, 1958). People of all faiths, genders, ages, physical abilities, and backgrounds can benefit from regular yoga practice, which enhances health, happiness, and quality of life (Sivananda, 1999).

Yoga improves mental and physical health, clarity, and self-awareness, helping individuals overcome challenges. Yogasanas involve twisting and stretching the body, enhancing circulation, muscle flexibility, and energy by improving oxygen intake and waste disposal (Iyengar, 2001). These practices result in relaxation and improved health, symbolizing tranquility and discipline. (Aakash et al., 2023) Yoga promotes ethics and self-discipline, fostering positivity, politeness, and analytical skills. Both theoretical and practical aspects of yoga are important, with the latter often emphasized (Saraswati, 1981).

Physical asanas strengthen internal organs and are essential for every yoga practice. (Jain et al., 2023) Regular practice enhances the body, mind, and intellect, affecting every cell and tissue, leading to excellence in body and mind – the highest human achievement (Kumar & Jhajharia, 2018, Iyengar, 2001).

Yoga as a Competitive Sport

The Ministry of Youth Affairs and Sports of the Indian government officially recognized yoga asana as a competitive sport on December 17, 2020, in a meeting attended by Shripad Yesso Naik, Minister of AYUSH, and Kiren Rijiju, Minister of Youth Affairs and Sports (Bureau, India, and Sports, 2020). Yoga competitions have a long history in India, with documented practices dating back over five thousand years (Feuerstein, 1998). The intellectual and spiritual content of yoga competitions has evolved over the past two thousand years alongside the proliferation of new yoga asanas (Eliade, 1958). The first yoga competition resembling modern ones is hypothesized to have occurred about 200 years ago. Swami Vivekananda introduced yoga to the West in the 1890s, promoting it across North America and Europe (Vivekananda, 1982).

In 1989, Swami Maitreyananda presided over the first World Yoga Championship competition in Montevideo, Uruguay. The same year, Pondicherry in India hosted the first international Yoga Asanas Championship, directed by Yoga Maharishi Dr. Swami Gitananda Giri (International Yoga Sports Federation, 2020). Today, yoga competitions are held worldwide, contributing to its recognition as a sport. The Indian Yoga Federation, founded in 1974, was officially recognized by the Indian Olympic Association from October 1998 to February 2011. Since 1991, yoga has been part of the all-India inter-university games, the national school games, and starting in 2022, the Khelo India Youth Games (International Yoga Sports Federation, 2020).

Talent Identification for Competitive Yoga

Yoga competitions typically feature three main categories: artistic, rhythmic, and traditional yogasana.

1. **Artistic Yogasana**: Similar to artistic gymnastics, performers hold postures for three minutes, matching their movements to music. Athletes' programs include 10 asanas, such as leg balance, hand balance, backbends, forward bends, and body twists. Artistic yogasana can be practiced solo or in pairs (International Yoga Sports Federation, 2020).
2. **Traditional Yogasana**: This event emphasizes balance and stability, requiring competitors to maintain postures for 15 or 30 seconds, depending on the asana (International Yoga Sports Federation, 2020).
3. **Rhythmic Yogasana**: Involves couples and groups of five practicing postures in unison, holding each for five to seven seconds, with points awarded for seamless transitions (International Yoga Sports Federation, 2020).

Yoga has evolved into a significant sports activity, helping children develop numerous skills and compete at the highest levels. Coaches and physical education teachers play a vital role in developing talent identification models for recognizing gifted young players (West, Nancy Shohet Whitworth, and Pollack, 2020).

Multiple Regression Analysis in Yoga Performance

Multiple regression analysis is a statistical method used to establish relationships between multiple variables, with one variable considered the dependent variable and others as independent variables. This method can determine the functional link between variables, even without a strict deterministic relationship (Li, Wang, Gu, & Cao, 2022). Multiple linear regression specifically studies the relationship between a dependent variable and two or more independent variables, reflecting the rule that the frequency of one phenomenon varies with the frequency of others (Li et al., 2022). This technique has been widely used in the sports world.

This study aims to identify the correlation between yogic performance and selected physical fitness variables and to develop a multiple regression model for predicting yogic performance (Li et al., 2022).

2. MATERIAL AND METHODS

SELECTION OF SUBJECTS

For the purpose of the study 25 yogasana players between the ages of 10 and 15 were selected for the study from Delhi-NCR region.

SELECTION OF VARIABLES

Sit-ups, push-ups, balance, and flexibility were chosen as independent physical fitness variables for the study, with yogic performance functioning as the dependent variable.

ADMINSTRATION OF TEST

Test	Purpose	Equipment	Administration	Scoring
Push-Ups	To measure the strength and endurance of the upper body.	Floor mat, stopwatch, and chair.	- The participant began with hands and toes touching the floor, body and legs straight, feet slightly apart, arms shoulder-width apart and extended at a right angle to the body. - The participant lowered the body to a predetermined point, touched the ground or another object, or until there was a 90-degree angle at the elbows, then returned to the starting position. - This action was repeated without rest until exhaustion or until the participant could not continue in rhythm or reached the target number of push-ups.	The total number of push-ups performed in one minute was recorded.
Sit-Ups	To measure the endurance of the abdominal and hip-flexor muscles.	Floor mat or carpet, stopwatch.	- The participant lay flat on a carpet or floor mat with knees bent at roughly 90 degrees and feet flat on the ground. - Hands were placed on the thighs, stomach was squeezed, back was flattened, and hands were elevated to rest on the tops of the thighs. - The participant kept the lower back flat on the floor and avoided using the neck or head to push, then returned to the starting position.	The total number of sit-ups performed in one minute was recorded.
Flexibility	To determine the back and lower body flexibility.	Sit and reach box.	- The participant sat on the floor with legs straight ahead, soles of the feet (shoes removed) flat against the box, shoulder-width apart. - Both knees were rested flat against the floor. - The participant stretched forward along the measuring line with hands on top of each other and palms facing down. - The distance was measured while the first reach was held for at least two seconds.	The best score closest to an inch out of three attempts was recorded.
Balance	To assess whole body balance ability.	Flat, non-slip surface, stopwatch, paper, and pencil.	- The participant removed shoes, placed hands on hips, and positioned the non-supporting foot against the inside knee of the supporting leg. - The participant practiced balance for one minute. - The heel was raised to balance on the ball of the foot. - The stopwatch was started as the heel was raised from the floor. - The stopwatch was stopped if any of the following occurred: - Hands came off hips - Supporting foot swiveled or moved - Non-supporting foot lost contact with the knee - Heel of the supporting foot touched the floor.	The best of three attempts was recorded in seconds.

3. STATISTICAL ANALYSIS

Pearson Correlation was conducted to determine the relationship between physical fitness variables and yogic performance. Additionally, multiple linear regression was applied to develop a performance prediction model. Statistical significance was considered at an α-level of $p < 0.05$. The statistical analyses were performed using SPSS version 20. The magnitude of effect for the correlations was interpreted using the following scale: trivial (<0.10), small (0.10-0.29), moderate (0.30-0.49), large (0.50-0.69), very large (0.70-0.89), and nearly perfect (>0.90) as per (Hopkins 2000).

RESULTS

Table No. 1 Descriptive statistics of physical characteristics of selected subjects.

Age (years)	Body Mass (kilogram)	Height (cm)
14±1.25	66±5.75	161.7±6.20

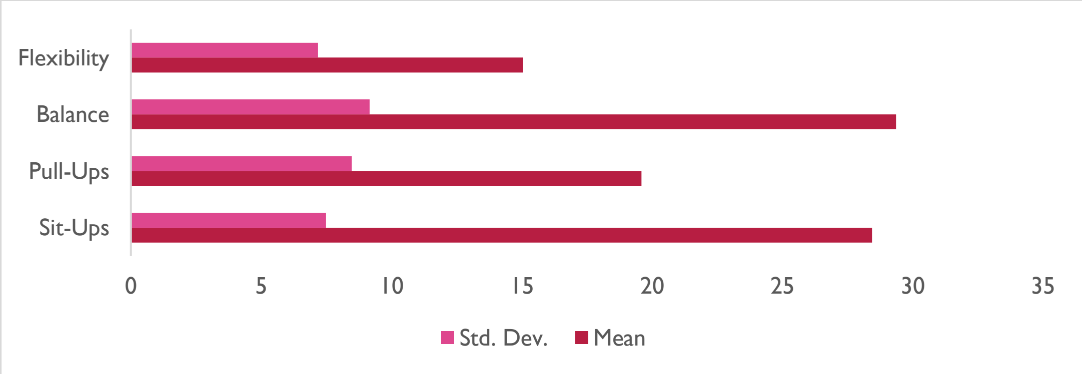

Fig No. 1 Graphical representation descriptive statistics of Physical fitness variables of selected subjects.

Table No. 2 Descriptive statistics of Physical fitness variables of selected subjects.

	Physical Fitness Variable	**Mean**	**Std. Dev.**
Dependent Variable	Sit-Ups	28.44	7.49
	Push-Ups	19.60	8.47
	Balance	29.36	9.16
	Flexibility	15.05	7.18

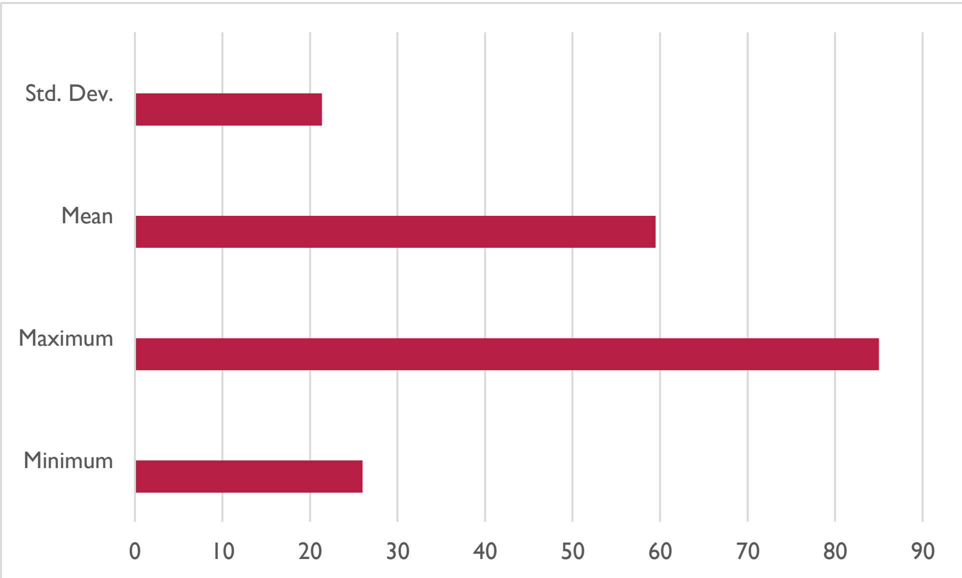

Fig No. 2 Graphical representation descriptive statistics of Yogic performance of selected subjects.

Table No. 3 Descriptive statistics of Yogic performance of selected subjects.

Independent Variable	**Minimum**	**Maximum**	**Mean**	**Std. Dev.**
Yogic Performance Score	26	85	59.50	21.368

Table No. 4 Correlation analysis of Physical fitness variables and Yogic performance

		Performance	Sit-ups	Push-ups	Flexibility	Balance
Performance	**Pearson Correlation**	1	.274	-.225	.622**	.271
	Sig. (2-tailed)		.185	.280	.001	.190
**. Correlation is significant at the 0.01 level (2-tailed).						
*. Correlation is significant at the 0.05 level (2-tailed).						

Table 1 presents the descriptive statistics of the research participants' age, weight, and height. The mean age of the participants was 14 years with a standard deviation of 1.25 years. The mean body mass was 66 kg with a standard deviation of 5.75 kg. The mean height was 171 cm with a standard deviation of 6.20 cm.

Table 2 and Figure 1 display the descriptive statistics for the physical fitness variables: sit-ups, push-ups, balance, and flexibility. The mean and standard deviation for sit-ups were 28.44±7.49, for push-ups were 19.60±8.47, for balance were 29.36±9.16, and for flexibility were 15.05±7.18.

Table 3 illustrates the descriptive data for yogic performance, which had a mean of 59.50 and a standard deviation of 21.368.

Table 4 shows the correlation analysis between the physical fitness variables and yogic performance. There was a significant positive correlation between yogic performance and flexibility ($p < 0.01$). However, there were insignificant correlations between yogic performance and sit-ups, push-ups, and balance ($p > 0.05$).

Table No. 5 Model Summary along with the values of R and R squares

Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.622[a]	.387	.360	17.09650
a. Predictors: (Constant), Flexibility				

The regression model generated by the SPSS have been presented in Table 5 with explanation below.

1. **R (Correlation Coefficient)**:
   - The value of R is 0.622. This coefficient measures the strength and direction of the linear relationship between the predictor variable (flexibility) and the dependent variable (yogic performance). An R value of 0.622 indicates a moderate positive correlation between flexibility and yogic performance.
2. **R Square (Coefficient of Determination)**:
   - R Square is 0.387. This indicates that approximately 38.7% of the variance in yogic performance can be explained by flexibility. In other words, flexibility accounts for 38.7% of the variability in yogic performance.
3. **Adjusted R Square**:
   - The Adjusted R Square value is 0.360. This value adjusts the R Square for the number of predictors in the model, providing a more accurate measure of the explained variance when there are multiple predictors. Here, it slightly reduces the R Square to account for the potential overestimation caused by adding more predictors.
4. **Std. Error of the Estimate**:
   - The standard error of the estimate is 17.09650. This value represents the average distance that the observed values fall from the regression line. A smaller standard error indicates a closer fit of the model to the data.

Table No. 5 summarizes the model that predicts yogic performance based on flexibility. The model shows a moderate positive relationship between flexibility and yogic performance, explaining 38.7% of the variance in the performance. The adjusted R Square accounts for the number of predictors, slightly reducing the explained variance to 36%. The standard error of 17.09650 indicates the average prediction error of the model.

Table No. 6 ANOVA table showing F-value for the obtained model

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4235.820	1	4235.820	14.492	.001[b]
	Residual	6722.680	23	292.290		
	Total	10958.500	24			
a. Dependent Variable: Performance						
b. Predictors: (Constant), Flexibility						

In table no. 6, F-Value for the obtained value is shown and explained below.

1. **Sum of Squares**:
   - **Regression**: The sum of squares due to regression (4235.820) measures the variation explained by the predictor variable (flexibility) in the model.
   - **Residual**: The sum of squares due to residuals (6722.680) measures the variation not explained by the predictor in the model. It represents the error or the unexplained variance.
   - **Total**: The total sum of squares (10958.500) is the sum of the regression and residual sum of squares. It measures the total variation in the dependent variable (yogic performance).
2. **df (Degrees of Freedom)**:
   - **Regression**: The degrees of freedom for the regression (1) correspond to the number of predictor variables in the model.
   - **Residual**: The degrees of freedom for the residual (23) are the total number of observations minus the number of parameters estimated (including the intercept and the predictor variable).
   - **Total**: The total degrees of freedom (24) are the total number of observations minus 1.
3. **Mean Square**:
   - **Regression**: The mean square for the regression (4235.820) is the sum of squares due to regression divided by its degrees of freedom (4235.820/1).
   - **Residual**: The mean square for the residual (292.290) is the sum of squares due to residuals divided by its degrees of freedom (6722.680/23).
4. **F-Value**:
   - The F-value (14.492) is the ratio of the mean square for regression to the mean square for residuals (4235.820 / 292.290). It tests whether the regression model provides a better fit to the data than a model with no predictors.
5. **Sig. (p-value)**:
   - The significance level (p-value) of .001 indicates the probability that the observed F-value could occur by chance. Since .001 is less than the commonly used significance level of .05, it suggests that the model is statistically significant.

Table No. 6 summarizes the ANOVA results for the regression model predicting yogic performance based on flexibility. The model's F-value of 14.492 and a p-value of .001 indicate that the regression model is statistically significant, meaning flexibility significantly predicts yogic performance. The regression sum of squares shows the variation explained by the model, while the residual sum of squares shows the unexplained variation. The total sum of squares represents the total variation in yogic performance.

Table No. 7 Regression coefficient of selected variable and their t-values and partial correlation

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	31.684	8.067		3.928	.001
	Flexibility	1.848	.485	.622	3.807	.001
a. Dependent Variable: Performance						

Table No. 7 presents the regression coefficients for the model predicting yogic performance based on flexibility.

1. **Unstandardized Coefficients (B)**:
   - Unstandardized coefficient "B" is used to develop the regression equation whereas, Standardized Coefficients "Beta" is used to explain their contribution towards dependent variable in the model. (Kumar & Jhajharia, 2020, Verma J P 2013) Using standardised regression coefficient shown in table no. 7 the regression equation is developed which is as follow:

Yoga Performance= 31.684+1.848 × (Flexibility)

   - **(Constant)**: The unstandardized coefficient for the constant is 31.684. This is the predicted value of the dependent variable (yogic performance) when all independent variables (flexibility) are equal to zero.
   - **Flexibility**: The unstandardized coefficient for flexibility is 1.848. This means that for each one-unit increase in flexibility, the yogic performance is expected to increase by 1.848 units, holding all other variables constant.

2. **Standard Error**:
   - The standard error for the constant is 8.067, and for flexibility, it is .485. This measures the accuracy of the coefficient estimates. Smaller standard errors indicate more precise estimates.

3. **Standardized Coefficients (Beta)**:
   - The standardized coefficient (Beta) for flexibility is .622. Standardized coefficients are useful for comparing the relative importance of each predictor in the model. A Beta value of .622 indicates a strong positive relationship between flexibility and yogic performance, after adjusting for the units of measurement. Thus, it may be concluded that the above regression equation is quite reliable as the value of R^2 is 0.622. In other words, flexibility variable in the regression equation explains 62.2% of the total variability in the yoga performance, which is quite good.

4. **t-Value**:
   - **(Constant)**: The t-value for the constant is 3.928. This tests whether the constant is significantly different from zero. A high t-value indicates that the constant is significantly different from zero.
   - **Flexibility**: The t-value for flexibility is 3.807. This tests whether the coefficient for flexibility is significantly different from zero. A high t-value indicates that flexibility is a significant predictor of yogic performance.

5. **Sig. (p-value)**:
   - **(Constant)**: The p-value for the constant is .001, which is less than the commonly used significance level of .05, indicating that the constant is significantly different from zero.
   - **Flexibility**: The p-value for flexibility is .001, indicating that the coefficient for flexibility is significantly different from zero. This suggests that flexibility is a significant predictor of yogic performance.

Table No. 7 presents the regression coefficients for the model predicting yogic performance based on flexibility. The unstandardized coefficient for flexibility indicates that each unit increase in flexibility corresponds to a 1.848 unit increase in yogic performance. The standardized coefficient shows a strong positive relationship between flexibility and performance. Both the constant and flexibility coefficients are statistically significant, with p-values of .001, indicating a significant contribution to the model. The t-values further confirm the significance of these predictors.

4. DISCUSSION ON FINDINGS

The present study aimed to investigate the relationship between physical fitness variables and yogic performance, utilizing Pearson correlation and multiple linear regression analysis. The key findings are summarized and discussed as follows: The descriptive statistics of the participants' physical characteristics indicated a mean age of 14 years (±1.25), a mean body mass of 66 kg (±5.75 kg), and a mean height of 171 cm (±6.20 cm), suggesting a relatively young sample with moderate variability in weight and height. The physical fitness variables, as shown in Table 2 and Figure 1, had mean values of 28.44 (±7.49) for sit-ups, 19.60 (±8.47) for push-ups, 29.36 (±9.16) for balance, and 15.05 (±7.18) for flexibility, indicating a range of fitness levels among participants. Yogic performance, as illustrated in Table 3, had a mean score of 59.50 (±21.368), reflecting significant differences in performance likely influenced by varying fitness levels. The correlation analysis in Table 4 revealed a significant positive correlation between yogic performance and flexibility ($r = .622$, $p < 0.01$), consistent with studies highlighting flexibility's role in enhancing yoga performance (Ross & Thomas, 2010). However, no significant correlations were found between yogic performance and sit-ups ($r = .274$, $p > 0.05$), push-ups ($r = -.225$, $p > 0.05$), or balance ($r = .271$, $p > 0.05$), contrasting with literature suggesting core strength and balance are crucial for advanced yoga practice (Cowen & Adams, 2007; Tran et al., 2001). These discrepancies might be due to the sample's age and fitness levels, where flexibility might be more critical. The regression model in Table 5 indicated that flexibility significantly predicts yogic performance ($R = .622$, $R^2 = .387$, Adjusted $R^2 = .360$, $p < 0.01$), explaining 38.7% of the variance. The standardized coefficient (Beta) for flexibility was .622, emphasizing its strong positive impact on performance. The ANOVA results in Table 6, with an F-value of 14.492 ($p < 0.01$), support the model's significance. The regression coefficients in Table 7 showed an unstandardized coefficient for flexibility of 1.848, meaning each unit increase in flexibility corresponds to a 1.848 unit increase in yogic performance, with a constant value of 31.684 representing the predicted performance when flexibility is zero. Both coefficients were statistically significant ($p < 0.01$), indicating the model's robustness.

The significant positive correlation between flexibility and yogic performance supports previous findings that flexibility is crucial for yoga practitioners. Flexibility allows for greater range of motion and the ability to perform various asanas with precision, which enhances overall yogic performance (Caldwell et al., 2010). This study's findings are consistent with Patel et al. (2012), who found that flexibility significantly contributed to yoga performance in their research. Conversely, studies such as those by Liem et al. (2018) suggest that while flexibility is important, other factors such as strength and balance may also play significant roles, which our study did not find to be significant predictors.

The correlations between yogic performance and sit-ups ($r = .274$) and push-ups ($r = -.225$) were not statistically significant. This indicates that core strength and upper body strength, as measured by sit-ups and push-ups, may not be as critical for overall yogic performance as flexibility. This finding is contrary to studies by Raj and Duraiswamy (2015), which suggested that core strength significantly impacts the ability to perform yoga postures. However, it aligns with the findings of Bhattacharya et al. (2016), who argued that flexibility and balance are more critical than muscular strength in yoga practice.

Balance showed a non-significant positive correlation with yogic performance ($r = .271$). This result suggests that while balance is an essential component of many yoga poses, its direct impact on overall yogic performance may not be as pronounced when compared to flexibility. This is supported by the findings of Miyashita et al. (2009), who found that flexibility had a stronger correlation with performance in yoga than balance. On the contrary, a study by Ko et al. (2013) emphasized the importance of balance, particularly for advanced practitioners, indicating that balance might be more critical for higher levels of performance.

In conclusion, this study highlights the significant role of flexibility in predicting yogic performance, while sit-ups, push-ups, and balance did not show significant predictive power. These findings underscore the importance of incorporating flexibility training into yoga practice for enhanced performance. Future research could explore the role of other variables such as mental focus, endurance, and the impact of consistent practice duration on yogic performance. Additionally, longitudinal studies could provide insights into how the development of these fitness variables over time influences performance outcomes.

5. CONCLUSION

The study aimed to explore the relationship between physical fitness variables and yogic performance among young yogasana players, revealing that flexibility significantly predicts yogic performance, explaining 38.7% of the variance, while sit-ups, push-ups, and balance did not show significant correlations. Descriptive statistics indicated moderate variability in physical characteristics and fitness levels among participants, with flexibility displaying the highest variability. The significant positive correlation between flexibility and yogic performance ($r = .622$, $p < 0.01$) emphasizes its importance in yoga, whereas core strength and balance, measured by sit-ups and push-ups, were not as critical. The regression model confirmed flexibility as a strong predictor, highlighting the need for yoga practitioners to prioritize flexibility training for enhanced performance outcomes. These findings suggest that while traditional fitness components are valuable, flexibility plays a more crucial role in achieving excellence in yogic performance, especially for young practitioners.

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