RESEARCH ARTICLE

INTERNATIONAL JOURNAL OF KINANTHROPOMETRY

DOI: 10.34256/ijk2619

Anthropometric Determinants and Predictive Modeling of Upper Body Strength in Athletes

Sanjay Kumar Prajapati [1,*], Mukesh Kumar Verma [2], Harshit Verma [3], Sanjeev Shivanagouda Patil [1], Susheel Gupta [4], Vivek Venugopal Pai [1]

[1] SAI LNCPE, Thiruvananthapuram, Kerala-695581, India.
[2] NCERT, New Delhi, India
[3] Sports University of Haryana, Haryana, India
[4] Ram Manohar Lohia Avadh University, Faizabad, Uttar Pradesh, India
* Corresponding author email: sanjay.hockey88@gmail.com
DOI: https://doi.org/10.34256/ijk2619
Received: 17-12-2025; Revised: 25-03-2026; Accepted: 02-04-2026; Published: 16-04-2026

Abstract

Introduction: The purpose of our study was to predict upper-body strength on the basis of anthropometric variables. **Methods:** A total of 50 male athletes were chosen as subjects for the study. The age criteria for the subjects were between 18 and 25 years. The anthropometric variables were chosen as independent variable i.e. Standing Height and Weight were obtained using an electronic scale (Seca Instruments Ltd. Hamburg, Germany) with a precision of up to .001m, Arm Span, Iliac Crest Height, Arm Length was measured with the Segmometer (Cescorf Flexible Segmometer), Sitting Height was measured with the Holtain Sitting Height Table, Girth Measurement (Biceps, Waist, Thigh, Calf, Hip) were determined using a Steel tape, Skin fold for Biceps, Triceps, Subscapular, Supraspinale, Thigh, Calf were obtained with a skinfold caliper and recorded in millimetres (Harpenden Skinfold). Body Composition was facilitated by Bioelectrical Impedance Analysis (BIA). Bone Breadth of Humerus, Femur, and Shoulder was measured by Small (CESCORF Slide Caliper) and large Sliding Caliper (Cescorf Large Sliding Caliper) and the dependent variable, i.e. Upper arm strength, was measured with bench press 1 RM Test. Pearson product-multiple correlation was used to find out the relationship between anthropometric variables and bench press strength. A regression equation was used to predict upper arm strength based on anthropometric characteristics. **Results:** A strong correlation (r = 0.791) indicates that body measurements collectively have a significant impact on upper body strength. R Square (.619) as a predictor was included, which means that 61.9% of the variance in the bench press was associated with changes in the anthropometric variable. **Conclusion:** Regression equation finding the combination of constant flexed arm girth could provide a reasonably good estimation of bench press performance.

Keywords: Upper Body Strength, Bench Press, Arm Girth, Performance.

Resumen

Introducción: El propósito de nuestro estudio fue predecir la fuerza del tren superior basándose en variables antropométricas. **Métodos:** Se seleccionó a un total de 50 atletas varones como sujetos para el estudio. El criterio de edad para los sujetos se estableció entre los 18 y los 25 años. Las variables antropométricas se eligieron como variables independientes; es decir, la estatura de pie y el peso se obtuvieron utilizando una báscula electrónica (Seca Instruments Ltd., Hamburgo, Alemania) con una precisión de hasta 0,001 m; la envergadura de los brazos, la altura de la cresta ilíaca y la longitud del brazo se midieron con un segmómetro (Segmómetro Flexible Cescorf); la estatura sentado se midió con la mesa de medición de estatura sentado Holtain; las medidas de perímetro (bíceps, cintura, muslo, pantorrilla y cadera) se determinaron utilizando una cinta métrica de acero; y los pliegues cutáneos del bíceps, tríceps, subescapular, supraespinal, muslo y pantorrilla se obtuvieron con un plicómetro y se registraron en milímetros (Plicómetro Harpenden). La determinación de la composición corporal se realizó mediante el Análisis de Impedancia Bioeléctrica (BIA). La anchura ósea del húmero, el fémur y los hombros se midió con un calibre deslizante pequeño (Calibre Deslizante Cescorf) y uno grande (Calibre Deslizante Grande Cescorf); por su parte, la variable dependiente —es decir, la fuerza del tren superior— se midió mediante la prueba de 1 Repetición Máxima (1 RM) en press de banca. Se utilizó la correlación múltiple producto-momento de

Pearson para determinar la relación entre las variables antropométricas y la fuerza en el press de banca. Se empleó una ecuación de regresión para predecir la fuerza del tren superior basándose en las características antropométricas. **Resultados:** Una correlación fuerte (r = 0,791) indica que las medidas corporales, consideradas en conjunto, tienen un impacto significativo en la fuerza del tren superior. Se incluyó el coeficiente R cuadrado (0,619) como indicador predictivo, lo cual significa que el 61,9 % de la varianza en el rendimiento del press de banca estuvo asociada a los cambios en las variables antropométricas. **Conclusión:** La ecuación de regresión, al combinar la constante y el perímetro del brazo flexionado, podría proporcionar una estimación razonablemente precisa del rendimiento en el press de banca.

Palabras Clave: Fuerza Del Tren Superior, Press De Banca, Perímetro Del Brazo, Rendimiento.

Introduction

Anthropometry is a good way to predict what the 1RM Bench press load would be (Caruso et al., 2012). Upper body strength is one of the main components of physical fitness, usually assessed through the Bench press test, which serves as a measure of athletic ability and shows the level of upper body power requirement in many sports. One of the main and basic tests of upper-body strength (Whisenant et al., 2003) used in strength training sessions and athletic performance evaluations is the bench press exercise. The Bench press is a complex exercise that works for the pectoralis major, anterior deltoid, and triceps brachii muscles. It is a good way to assess maximum upper body strength in a variety of sports (Caruso et al., 2012). Understanding the relationship and influence of anthropometrical variables has significant implications for Talent identification, training program optimization, and performance prediction in athletes.

Body measurements such as body mass, limb lengths, muscle cross-sectional area, and body composition are examples of anthropometric characteristics that have become important indicators of strength performance (Keogh et al., 2006). Anthropometric measurement is a useful method for predicting the strength of ideal body dimensions and limb proportions that offer mechanical benefits, which improve lifting performance.

Several studies have repeatedly shown that certain anthropometric factors and bench press performance are strongly correlated. One of the most reliable indicators of absolute bench press strength is Body mass (Mayhew et al., 1993). Skill, Experience, Fat mass, and Muscle mass indices for the upper and lower limbs can be used to predict Lift performance level both individually and collectively (Ferrari et al., 2022).

Muscular strength is a main determinant of success in many sports and is also essential for various functional activities of daily life (Keogh et al., 2005). The one-repetition maximum (1RM) test is widely used to assess muscular strength. To achieve a 1RM lift, one must generate maximum muscular torque to offset the torque generated by the weight. The muscular torque is equal to the muscular force(s) multiplied by the muscle’s moment arm of the load (Keogh et al., 2005; McGinnis, 2013).

It is possible to determine the moment arm of the load and the muscles' capacity to generate force using anthropometric profiling. The cross-sectional area of a muscle determines how much force it can generate (Komi, 1994) as well as rising with higher Fat Free mass (FFM) levels (Brechue & Abe, 2002). Therefore, a person's strength may be inferred from common anthropometric parameters, including body mass, FFM, Mesomorphy, and Trunk/Limb girths (Keogh et al., 2005). The distance measured perpendicularly from the load's line of draw to the joint that is rotating is known as the load's moment arm (Iaquinto, 2022). Accordingly, as the lifter's limb length rises, the load's moment arm and, consequently, its torque, increase. Therefore, the limbs of powerlifters and Olympic weightlifters are generally proportionately shorter than those of the general population (Keogh et al. 2007).

Even after the extensive body of research, there are still several unanswered questions regarding the anthropometric determinants of upper body strength, hence the relationship between upper body strength and anthropometric variables of prediction of upper body strength on the basis of upper body strength demand additional investigation.

The present study was aimed to address these gaps by examining the relationship and predicting the upper body strength on the basis of anthropometric variables.

Methodology

Subjects: A total of 50 male athletes were chosen as the subjects for the study. The age criteria for the subjects were between 18 and 25 years.

Anthropometric Measurements: Anthropometric measurements were donef ollowing the standard methods standardized by International Society for The Advancement of Kinanthropometry (Esparza-Ros et al., 2019).

Stretch Height was measured with a Stadiometer and Body Mass was measured with an electronic weighing scale (Seca Instruments Ltd., Hamburg, Germany). Arm Span, Iliac Crest Height, Arm Length were measured with ta Segmometer (CESCORF, Brazil). Sitting Height was measured with a Holtain Sitting Height Table, Circumferences of Biceps, Waist, Thigh, Medial, Calf and Hip were measured using an Anthropometric Tape. Skinfold thickness of Biceps, Triceps, Subscapular, Supraspinale, Thigh and Calf sites were measured with a Harpenden Skinfold Caliper. Body Composition was measured with a Bioelectrical Impedance Analysar (BIA). Bone Breadth (Humerus, Femur, Shoulder) was measured with a Small Sliding caliper and Large Sliding Caliper (CESCORF, Brazil).

Strength: Upper arm strength, was measured with bench press 1 RM Test.

Descriptive statistics: Pearson product-moment correlation and regression equation were used to find out multiple correlations and to predict the bench press strength on the basis of anthropometric characteristics.

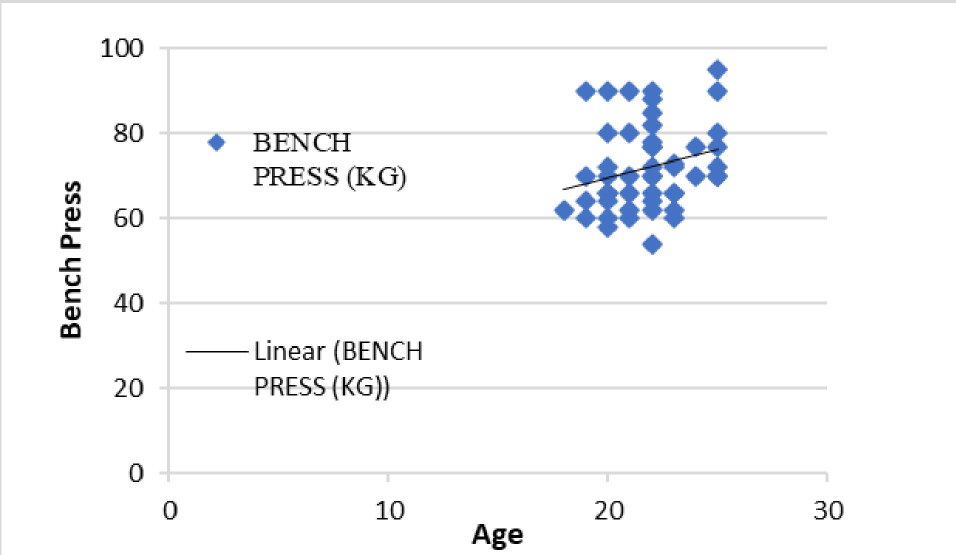

Figure 1. Relationship between Age and Bench press

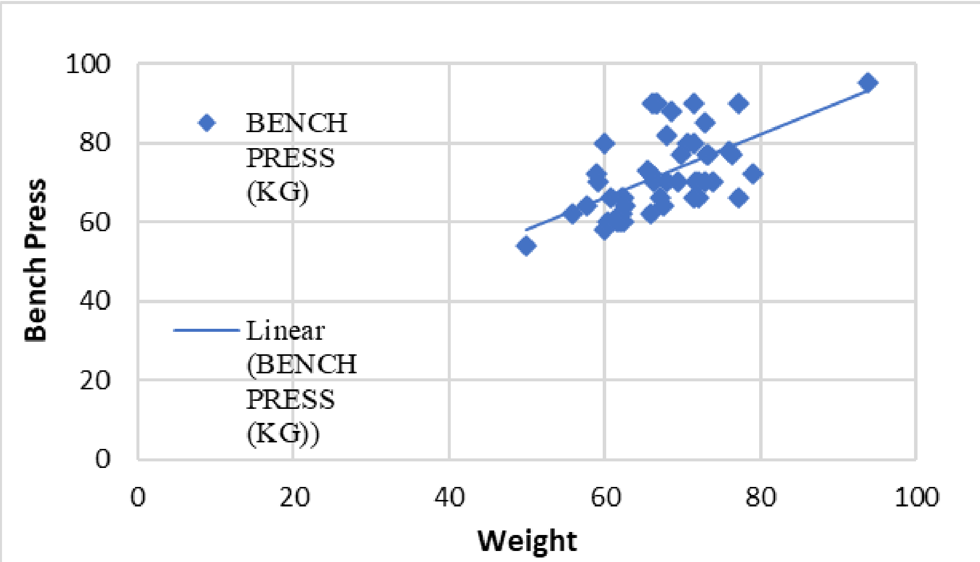

Figure 2. Relationship between Weight and Bench press

Table 1 shows the correlation of Bench press (dependent variable) with anthropometric characteristics (Independent variable), Age, Weight, BMI, Flexed Arm Girth, Thigh Girth, Calf Girth, Hip Girth, Arm Span, Arm Length, Body Fat Mass, Fat Free Mass, Skeletal Muscle Mass, Triceps Skinfold, Calf Skinfold, and Shoulder Breadth, were Found Significantly Correlated with the Bench Press, Among the Variables, Waist Girth, Iliac Crestal

Height, Sitting Height, Percent Body Fat, Biceps Skinfold, Sub Scapula Skinfold, Supra Spinal Skinfold, Thigh Skinfold, Humerus Breadth, and Femurs Breadth were found not significantly correlated with the Bench Press.

Results

Table 1. Means, Standard Deviations, and Correlation Matrix between Bench Press and Anthropometric Variables including age.

Variables	Mean	Std. Deviation	Correlation Coefficient (r)	Significant Value
Bench press (kg)	72.02	10.07	-	
Age (yr)	21.78	1.87	0.3	0.038
Height (cm)	171.60	7.17	0.3	0.077
Weight (Kg)	67.52	7.27	0.6*	0.000
BMI (Kg/M²)	22.832	2.22	0.7*	.000
Flexed Arm Girth (Cm)	32.04	2.24	0.8*	.000
Waist Girth (Cm)	75.54	5.71	0.3	.064
Thigh Girth (Cm)	52.78	2.97	0.6*	.000
Calf Girth (Cm)	35.34	4.68	0.3	.025
Hip Girth (Cm)	91.62	5.33	0.4*	.004
Arm Span (Cm)	177.72	9.03	0.4*	.004
Arm Length (Cm)	76.10	4.14	0.4*	.003
Iliac Crest Height (Cm)	99.20	7.96	0.2	.119
Sitting Height (Cm)	87.28	4.02	0.1	.489
Body Fat Mass (Kg)	9.776	4.6	0.4*	.012
Fat Free Mass (Kg)	57.620	5.65	0.5*	.000
Skeletal Muscle Mass (Kg)	32.802	3.36	0.5*	.000
Body Fat (%)	14.255	5.40	0.2	.089
Biceps Skinfold (Cm)	4.34	1.23	-0.1	.409
Triceps Skinfold (Cm)	11.24	4.67	0.4*	.014
Subscapular Skinfold (Cm)	13.34	5.43	0.2	.066
Supraspinale Skinfold (Cm)	8.88	4.91	0.1	.225
Thigh Skinfold (Cm)	12.54	4.27	0.2	.120
Calf Skinfold (Cm)	7.86	3.83	0.4*	.004
Humerus Breadth (Cm)	6.34	.47	0.2	.148
Femur Breadth (Cm)	9.28	.64	0.2	.115
Shoulder Breadth (Cm)	40.08	1.93	0.5*	.002

Discussion

In the present study, significant relationships were observed between upper body strength and different variables like age, weight, BMI, flexed arm girth, thigh girth, calf girth, hip girth, arm span, arm length, body fat mass, fat-free mass, skeletal muscle mass, triceps skinfold, calf skinfold, and shoulder breadth. These findings enhanced the notion that both body composition and segmental dimensions contribute to strength performance, particularly in movements requiring stabilization and maximal force generation. The study also revealed that Bench Press performance does not influenced by height, waist girth, iliac crest height, sitting height, percentage body fat, and number of skinfold measures (biceps, subscapular, supra-spinal, thigh), as well as Humerus and Femur breadths. This suggests that while some anthropometric variables have impression on upper body strength but not all variables. It has been observed that flexed arm girth emerged as the most influential variable in Bench press performance. These finding aligns with earlier literature which emphasizes the importance of upper arm muscle size and cross-sectional area (CSA) in determining maximal strength. Larger arm girth reflects greater muscular development, which enhances elbow joint stabilization, bar control and neuromuscular efficiency, particularly during the eccentric phase of lifting. This strong predictive value is further supported by Keogh et al., who reported that flexed arm girth combined with arm length-to-height ratio explained a substantial proportion of variance in bench press outcomes ($r^2 = 0.71$).The present findings was also very similar with the findings of Mayhew and Ball (1992) which also showed a significant correlation ($r = 0.83$) between upper arm circumference and one-repetition maximum (1RM) bench press performance. Mayhew and Ball (1992) highlighted the direct role of upper limb muscle size in maximal strength capacity, further validating the current study's outcome.

Thus the present study emphasized that muscle girth, particularly of the upper arm, serves as a reliable anthropometric indicator of upper body strength performance in Bench press. The study showed that flexed arm girth alone is a reliable predictor of bench press performance in athletes. This has practical implications for sports scientists, coaches, and trainers. In athletic training, anthropometric insights can help design individualized strength programs that focus on muscle hypertrophy in specific body regions that affect performance. In talent identification, anthropometric profiling can help identify individuals with natural strengths in strength-based sports. The study also suggests that evaluating potential for upper body strength should consider not only overall body size but also segmental muscularity.

Conclusion

The study concludes that excessive screen time is closely associated with lower physical activity and higher body fat among college students. Male students were generally more active and had lower body fat, whereas female students showed a stronger reduction in activity with greater screen exposure. These findings emphasize the need for balanced technology use and regular physical activity during the early adult transition stage.

References

Bice, M.R., Ball, J.W., Hollman, A., Adkins, M. (2019). Health Technology Use: Implications for Physical Activity Behaviors Among College Students. *International Journal of Kinesiology in Higher Education*, 3(1), 23–34. https://doi.org/10.1080/24711616.2018.1516524

Calestine, J., Bopp, M., Bopp, C.M., Papalia, Z. (2017). College Student Work Habits are Related to Physical Activity and Fitness. *International Journal of Exercise Science*, 10(7), 1009–1017. https://doi.org/10.70252/XLOM8139

Esparza-Ros, F., Vaquero-Cristóbal, R. and Marfell-Jones, M., 2019. *International standards for anthropometric assessment*. International Society for the Advancement of Kinanthropometry (ISAK).

Fountaine, C., Liguori, G., Mozumdar, A., Kincaid, J., Kouba, S. (2008). Television Viewing, Screen Time, and Physical Activity in College Students. *Medicine & Science in Sports & Exercise*, 40(5), S438. https://doi.org/10.1249/01.mss.0000322865.70399.29

Fountaine, C., Liguori, G., Mozumdar, A., Schuna, J. (2011). Physical Activity and Screen Time Sedentary Behaviors in College Students. *International Journal of Exercise Science*, 4(2), 102–112. https://doi.org/10.70252/IUHK4065

Fountaine, C.J., Liguori, G., Mozumdar, A. (2009). Screen Time is Not an Impediment to Physical Activity in College Students. *Medicine & Science in Sports & Exercise*, 41(5), 22–23.

Ge, Y., Xin, S., Luan, D., Zou, Z., Bai, X., Liu, M., Gao, Q. (2020). Independent and combined associations between screen time and physical activity and perceived stress among college students. *Addictive Behaviors*, 103, 106224. https://doi.org/10.1016/j.addbeh.2019.106224

Lavados-Romo, P., Andrade-Mayorga, O., Morales, G., Muñoz, S., Balboa-Castillo, T. (2023). Association of screen time and physical activity with health-related quality of life in college students. *Journal of American College Health*, 71(5), 1504–1509. https://doi.org/10.1080/07448481.2021.1942006

Ma, C., Zhou, L., Xu, W., Ma, S., Wang, Y. (2020). Associations of physical activity and screen time with suboptimal health status and sleep quality among Chinese college freshmen: A cross-sectional study. *PLOS ONE*, 15(9), e0239429. https://doi.org/10.1371/journal.pone.0239429

Torres, L., Caciula, M.C., Tomoiaga, A.S., Gugu-Gramatopol, C. (2023). Correlations between Mental Health, Physical Activity, and Body Composition in American College Students after the COVID-19 Pandemic Lockdown. *International Journal of Environmental Research and Public Health*, 20(22), 7045. https://doi.org/10.3390/ijerph20227045

Wu, X., Tao, S., Zhang, Y., Zhang, S., Tao, F. (2015). Low Physical Activity and High Screen Time Can Increase the Risks of Mental Health Problems and Poor Sleep Quality among Chinese College Students. *PLOS ONE*, 10(3), e0119607. https://doi.org/10.1371/journal.pone.0119607

Zanovec, M., Lakkakula, A., Johnson, L., Tuuri, G. (2009). Physical Activity is Associated with Percent Body Fat and Body Composition but not BMI in White and Black College Students. *International Journal of Exercise Science*, 2(3), 175–185. https://doi.org/10.70252/MDOK6464

Acknowledgments

Our deepest appreciation goes to the anthropometrists for their support, and a special thanks to everyone who participated in this project.

Funding

There is no external funding to declare

Conflicts of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Informed Consent Statement

All the athletes included in the study provided written informed consent.

About the License