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A Comparison of Vertical Jump Performance between Mesomorphic and Ectomorphic Dominant Somatotypes

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Resumen

Introducción: El rendimiento del salto vertical es una medida importante de la potencia de las piernas y la explosividad en los deportes. El somatotipo, que se refiere a la forma y composición del cuerpo, puede estar relacionado con la capacidad de salto vertical. Este estudio tuvo como objetivo comparar el salto vertical, la potencia anaeróbica máxima y las capacidades anaeróbicas relativas entre los somatotipos ectomorfo-mesomorfo y mesomórfico-ectomorfo entre estudiantes varones sedentarios. **Métodos:** En este estudio participaron un total de 26 estudiantes. Los participantes se sometieron a evaluaciones antropométricas para determinar las calificaciones de somatotipo de Heath-Carter. Además, se realizaron saltos con contramovimiento para evaluar la altura del salto vertical, estimar la potencia anaeróbica máxima mediante la ecuación de Sayers y calcular la relación potencia-masa corporal. **Resultados:** No se encontraron diferencias estadísticamente significativas entre ectomorfos-mesomorfos (n=15) y mesomorfos-ectomorfos (n=11) para salto vertical (54,47 ± 8,33 cm vs 57,09 ± 6,28 cm, p = 0,25), potencia anaeróbica máxima (3576 ± 542,01 W vs 3473,47 ± 538,71 W, p = 0,64), o relación potencia-masa corporal (69,97 ± 10,51 W/kg vs 65,10 ± 7,46 W/kg, p = 0,18). **Conclusión:** Si bien este estudio inicial no sugirió diferencias sustanciales en el rendimiento según el somatotipo, se necesitan más investigaciones con mayor poder estadístico a través de tamaños de muestra más grandes para determinar de manera concluyente las relaciones entre el físico y las capacidades anaeróbicas en la población general. Emparejar y seguir a los atletas durante el entrenamiento deportivo también puede aclarar las ventajas conferidas únicamente por la morfología.

Palabras Clave: Antropometría, Sedentarismo, Potencia anaeróbica, Relación potencia-masa corporal.

Abstract

Introduction: Vertical jump performance is an important measure of leg power and explosiveness in sports. Somatotype, referring to body shape and composition. It may relate to vertical jump capacity. This study aimed to compare vertical jump, peak anaerobic power, and relative anaerobic capabilities between ectomorphic-mesomorph and mesomorphic-ectomorph somatotypes among sedentary male students. **Methods:** A total number of 26 students participated in this study. Participants underwent anthropometric assessments to determine Heath-Carter somatotype ratings. Additionally, countermovement jumps were performed to evaluate vertical jump height, estimate peak anaerobic power via the Sayers equation, and calculate a power-to-body mass ratio. **Results:** No statistically significant differences were found between ectomorphic-mesomorphs (n=15) and mesomorphic-ectomorphs (n=11) for vertical jump (54.47 ± 8.33 cm vs 57.09 ± 6.28 cm, p = 0.25), peak anaerobic power (3576 ± 542.01 W vs 3473.47 ± 538.71 W, p = 0.64), or power-to-body mass ratio (69.97 ± 10.51 W/kg vs 65.10 ± 7.46 W/kg, p = 0.18). **Conclusion:** While this initial study suggested no substantial performance differences based on somatotype, further research with increased statistical power through larger sample sizes is necessary to conclusively determine relationships between physique and anaerobic capacities in the general population. Matching and tracking athletes over sports training may also clarify advantages conferred by morphology alone.

Keywords: Anthropometry, Sedentary, Anaerobic Power, Power-to-body mass ratio

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Introduction

Vertical jump is an integral physical capacity for success across many sports. It remains one of the most widely utilized and informative tools for assessment leg explosive power. A number of studies has emphasized the importance of vertical jump assessment as it measures an athlete's lower body power and explosiveness (Sayers et al., 1999). It is believed that vertical jumping ability shows better results in the variables including speed and explosiveness in various team sports (Barr et al., 2014; Zary et al., 2010). Assessing vertical jump performance might be effective for monitoring changes in neuromuscular capabilities over time (Aerenhouts et al., 2012). It could provide coaches with critical information relating to an athlete's capacities.

Various factors including physiological elements, biomechanical aspects, and different types of training interventions can influence leg explosive power (Tsolakis et al., n.d.; Wang et al., 2023; Zamparo et al., 2000). These factors collectively play a significant role in determining an individual's ability to generate force and power through their legs. Among these factors, somatotypes of the individual also hold an importance by influencing this explosive ability. Somatotype refers to the body shape and composition of an individual, categorized as endomorph, mesomorph or ectomorph (Carter et al., 2005). Multiple studies have examined relationships between somatotype and performance outcomes like vertical jump. A study on Brazilian youth soccer players, classified as balanced mesomorphs somatotypes showed highest performance in vertical jumps (Fidelix et al., 2014). It was also found that Mesomorphy positively correlated with countermovement jump in male handball players (Moncef et al., 2012). Similarly, mesomorph dominant female volleyball players also exhibited higher vertical jump scores (Zary et al., 2010).

A few studies move beyond simple correlations to predict vertical jump performance based on somatotypes. (Cinarli et al., 2019) developed regression equations using somatotype ratings, limb girths, and body fat percentage to estimate vertical jumping ability. However, these prediction models were formed and tested on the same sample of physical education students rather than separate groups or athletes (Cinarli et al., 2022). Thus, a cross-validation is necessary to determine actual effectiveness for estimating vertical jump capacity among different population. During an investigation in the jumping abilities of individuals trained in the gym, (Ryan-Stewart et al., 2018) discovered that somatotyping proved to be a superior predictor of static jump height, whereas fat-free mass was a better predictor for countermovement jump height. Expanding these findings to additional populations can clarify if a universal vertical jump prediction method exists or if unique models are needed to developed based on the games and sports.

While studies (Cinarli et al., 2022; Fidelix et al., 2014; Moncef et al., 2012; Ryan-Stewart et al., 2018; Zamparo et al., 2000) have established general connections somatotypes and vertical jump, there remains a lack of agreement on optimal somatotypes for maximal performance across different sports. Some studies directly compare relationships between somatotype and vertical jump across sports to determine if there is a distinct trends exist or not. While other studies are rarely accounts for potential confounding from training exposures. Athletes specializing in vertical jump may increase ability regardless of genetics. However, understanding interactions between somatotype and sport training can better describe any performance advantages conferred by physique alone.

Numerous studies highlight associations between somatotype and vertical jump across athlete groups. However only few studies has done on the sedentary persons (Cinarli et al., 2022). Therefore, the present study was aimed to compare the vertical jump performance between the mesomorphic-ectomorph and ectomorphic-mesomorph somatotypes of sedentary persons only. The present study focused on two specific body types because of their prevalent presence in various sports and games (Burdukiewicz et al., 2018; Çatıkkaş et al., 2013; Phukon et al., 2023; Ryan-Stewart et al., 2018) . In addition, the present study also assessed the Peak Aerobic power and Power to Body Weight ratio between these two somatotypes. Studying the connection between somatotype and jump performance can provide valuable insights into how body composition might affect an individual's ability to perform in activities requiring explosive power, like jumping. Identifying optimal physiques for vertical jump in non-athlete groups can be used during talent identification and development processes.

Materials and Methods

Participants: A total number of 26 sedentary students (age 18±1.23 years) were purposively selected for this study. The participants were regular students from 3 Government Higher Secondary School in Rajgarh area of Dibrugarh District, Assam (India). All the participants were confirmed that they were not undergoing in any kind of regular training or involving with any kind of professional sports. A written consent was taken prior to the collecting data.

Data collection: The study was conducted over two consecutive days. On the first day, in morning session all the anthropometric data were collected and somatotypes of the participants was determined. The participants having either ectomorphic-mesomorph or mesomorphic-ectomorph somatotypes were selected for second day's vertical jump test. A written consent was taken from the schools prior to the collection of the data. All anthropometric measurements were taken according to guidelines given by ISAK (The International Society for Advancement of Kinanthopometry). The measurements were taken by ISAK level-1 Anthropometrist only (Table 1).

Table 1. Description of sites for measure, equipment's used and unit of measure

Sites for the measurements	Measuring Equipments	Measuring units
Standing Height	Stadiometer (Seca 213)	Centimeter (cm)
Body mass	Weighing machine (Hoffen Digital weighing machine)	Kilogram (kg)
Skinfolds sites (triceps, subscapular, supraspinale, medial calf)	Harpenden calliper (Galaxy)	Millimeter (mm)
Biepicondylar humerus and femur	Sliding calliper (Cescorph)	Centimeter (cm)
Biceps circumference and mid-calf circumference	Anthropometric tape (Cescorph)	Centimeter (cm)

Jump Test Procedure: The vertical jump (VJ) height was assessed using the countermovement jump. Participants instructed to regulate arm movement and maintain their hands on their hips throughout the jump. The trial was considered valid when participants fully extended their knee joints during both the flight and the initial landing. A rest period of 2 minutes was given between each jump attempt. The highest jump height (in centimeters) from three maximum effort trials was chosen for further data analysis.

Determining Anaerobic Power and Power to Body Mass Ratio: These parameters were calculated based on the highest achieved vertical jump out of three attempts (VJ). Anaerobic power, measured in watts (PAPw), was determined utilizing the Sayers equation, represented as:

PAP.w = 60.7 × jump height (in centimeters) + 45.3 × body mass (in kilograms) – 2055 (Sayers et al., 1999).

Furthermore, the power-to-body-mass ratio (P:BM) was derived by dividing PAPw by the body mass through the formula:

P:BM = PAPw / body mass (in kilograms) (Jalilvand et al., 2019).

Data processing: The collected data underwent analysis using MS Excel (2021) and SPSS version 23. Descriptive statistics were utilized to present the data appropriately. To ascertain the significance of the difference between the two specific somatotypes, a 't-test' was employed at a significance level of 0.05.

Result

In the following section result of the present study is displayed.

In the table 2, descriptive statistics Mean, standard deviation, range and 95% confidence interval of participants with Ectomorphic-mesomorph somatotypes (n=15) is presented. It was found that average endomorph, mesomorph and ectomorph characteristics were 1.73±0.38 4.13±0.59 & 2.92±0.57 respectively.

In the table 3, descriptive statistics Mean, standard deviation, range and 95% confidence interval of participants with Mesomorphic-ectomorph somatotypes (n=11) is presented. It was found that average endomorph, mesomorph and ectomorph characteristics were 1.50±0.41, 2.96±0.47 & 4.63±0.47 respectively.

The table 4 is providing comparison between two different body types: Ectomorphic-Mesomorph and Mesomorphic-Ectomorph. Each variable's mean values were examined alongside a p-value.

Table 2. Descriptive statistics of anthropometric characteristics of Ectomorphic-mesomorph (n = 15) somatotypes

Variables	Mean ± SD	Range	95% Confidence Interval
Weight (kg)	56.51±5.60	43.80-65.20	53.67-59.34
Height (cm)	164.69±4.54	157.8-173.5	162.39-166.99
Biceps Skin fold (mm)	2.99±0.35	2.30-4	2.81-3.16
Triceps Skin fold (mm)	5.27±1.22	3-7	4.65-5.89
Sub Scapula Skin fold (mm)	8.27±1.58	6-11	7.47-9.07
Supra Spinale Skin fold (mm)	4.30±1.39	3-7	3.60-5
Mid Calf Skin fold (mm)	4.67±0.90	3-6	4.21-5.12
Arm Girth (cm)	27.33±1.94	24-32	26.34-28.31
Calf Girth (cm)	32.85±2.28	27-36	31.7-34.01
Bicondylar Humerus (cm)	6.43±0.33	6-7.30	6.26-6.6
Bicondylar Femur (cm)	9.05±0.42	8.40-9.9	8.83-9.26
Endomorphy	1.73±0.38	1.26-2.38	1.53-1.92
Mesomorphy	4.13±0.59	2.9-4.9	3.83-4.43
Ectomorphy	2.92±0.57	2.09-4.38	2.64-3.21

Table 3. Descriptive statistics of anthropometric characteristics of Mesomorphic-Ectomorph (n=11) somatotypes

Variables	Mean ± SD	Range	95% Confidence Interval
Weight (kg)	53.43±5.54	43.65-61.8	50.63-56.27
Height (cm)	170.49±6.73	158.6-181.6	167.08-173.9
Biceps Skin fold (mm)	2.64±0.45	32.00	2.41-2.87
Triceps Skin fold (mm)	5.09±1.14	47.00	4.52-5.67
Sub Scapula Skin fold (mm)	6.77±2.02	5.12	5.75-7.79
Supra Spinale Skin fold (mm)	4.73±1.25	3.50-8	4.09-5.36
Mid Calf Skin fold (mm)	3.95±0.99	3-5.50	3.46-4.45
Arm Girth (cm)	25.75±1.90	22.5-29.2	24.78-26.71
Calf Girth (cm)	31.83±1.73	29-33.9	30.95-32.71
Bicondylar Humerus (cm)	6.59±0.23	6.3-7	6.47-6.71
Bicondylar Femur (cm)	8.87±0.37	8.1-9.5	8.69-9.06
Endomorphy	1.50±0.41	1.03-2.39	1.29-1.71
Mesomorphy	2.96±0.47	2.07-3.54	2.72-3.20
Ectomorphy	4.63±0.47	3.84-5.4	4.40-4.87

For the variable Vertical Jump (VJ), the mean for Ectomorphic-Mesomorph was found to be 54.47 (±8.33), while for Mesomorphic-Ectomorph, it was 57.09 (±6.28), resulting in a p-value of 0.25 (table 4). Similarly, the variable Peak anaerobic power (PAP.w) displayed means of 3576 (±542.01) for Ectomorphic-Mesomorph and 3473.47 (±538.71) for Mesomorphic-Ectomorph, yielding a p-value of 0.636. Lastly, P:BM showcased means of 69.97 (±10.51) for Ectomorphic-Mesomorph and 65.10 (±7.46) for Mesomorphic-Ectomorph, with a p-value of 0.18 (Table 4).

Table 4. Comparison of the Vertical jump performance (VJ), Peak anaerobic power (PAP.w) and power to body mass ratio (P:BM) between the Ectomorphic-Mesomorph and Mesomorphic-Ectomorph somatotypes

Variables	Ectomorphic-Mesomorph (n=15)	Mesomorphic-Ectomorph (n=11)	p-value
VJ(cm)	54.47±8.33	57.09±6.28	0.25
PAP.w(watt)	3576±542.01	3473.47±538.71	0.636
P:BM (watt/kg)	69.97±10.51	65.10±7.46	0.18

Significance level=0.05

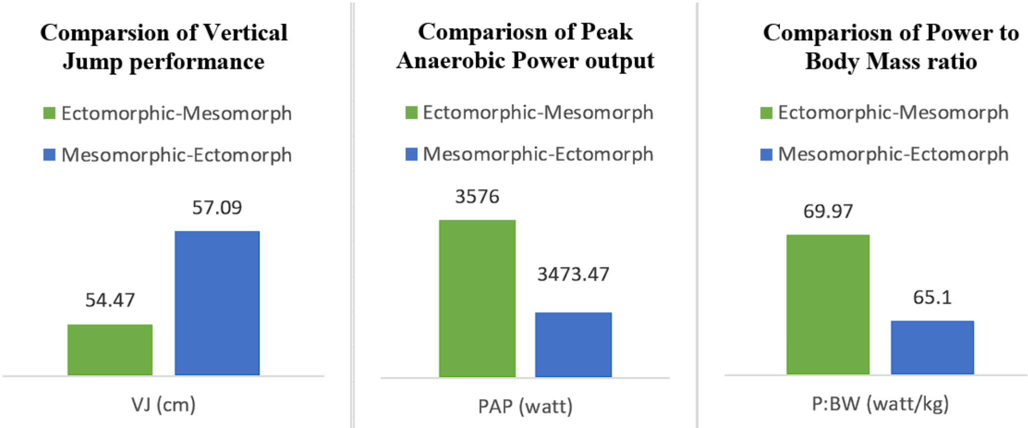

Figure 1. Graphical representation of comparison of mean value of vertical jump performance (cm), peak anaerobic power (watt) and power-to-body mass ration (watt/kg)

Discussion

The study compared individuals categorized as ectomorphic-mesomorphs and mesomorphic-ectomorphs across three performance measures: vertical jump (VJ) height, peak anaerobic power (PAP.w) and power-to-body mass ratio (P:BM). Despite slight numerical differences in means for these measures between the two groups, the statistical analysis revealed no significant disparities. The p-values for each comparison (VJ: 0.25, PAP.w: 0.636, P:BM: 0.18) exceeded the threshold for significance (usually set at 0.05), indicating that the observed variations in performance metrics were not statistically significant between the ectomorphic-mesomorph and mesomorphic-ectomorph groups.

Laubach & McConville (1969) explored 89 college athletes, using Heath-Carter somatotyping and a jump and reach test. Despite a positive correlation between mesomorphic traits and vertical jump, they (Laubach & McConville, 1969) noted a non-significant difference between ectomorphic-mesomorphs (mean VJ = 19.8 inches) and mesomorphic-ectomorphs (mean VJ = 18.6 inches). Their suggestion inferred ectomorphic and endomorphic elements may moderate jumping ability between somatotypes. Similarly, Marta and his colleague (2013) examined 80 prepubertal boys employing Heath-Carter methods and contact mats. They (Marta et al., 2013) found no significant vertical jump differences between balanced ectomorph-mesomorphs (mean VJ = 22cm) and balanced mesomorph-ectomorphs (mean VJ = 24cm) after adjusting for maturation. Their proposal hinted at delayed neuromuscular impacts between somatotypes. In contrast, Kandel et al. (2014) studied 65 adult male Ironman athletes using Carter & Heath protocols. Study reported that ectomorphic-mesomorphs (mean VJ = 50.37cm) and mesomorphic-ectomorphs (mean VJ = 51.25cm) showed no significant vertical jump differences. Further author justified the results with potential muscular adaptation to the specific training (Kandel et al., 2014). These insights emphasize factors like training responses, maturation and somatotype interactions may influence explosive movement capacities between groups.

Although the current research didn't identify significant differences in vertical jump performance between ectomorphic-mesomorph and mesomorphic-ectomorph somatotypes, conflicting findings are present. Some studies have indicated that individuals with mesomorphic and muscular builds tend to exhibit superior vertical jump capabilities (Cinarli et al., 2022; Lewandowska et al., 2011; Saha, 2014). For instance, Saha (2014) discovered that athletes dominant in mesomorph traits displayed 34-37% higher vertical jump heights compared to ectomorphic athletes. They suggest that the greater development of fast-twitch-muscle could provide mechanical advantages for explosive movements. However, Laubach & McConville (1969) argued that strength-to-weight ratios, rather than sheer muscularity alone, are the foundation of jumping ability. They (Laubach & McConville, 1969) point out that lighter ectomorphs might express greater relative power. While it's evident that morphological factors influence physical capabilities, there's ongoing disagreement concerning the extent and mechanisms behind these intricate relationships in various sports, events, and competitive levels (Marta et al., 2013). As emphasized by Carter & Heath (1990), there's no single somatotype that guarantees athletic success. However, conducting well-controlled studies to track changes within athletes over time is essential to better understand the distinct impacts of sports training (Kandel et al., 2014).

The current study examined differences in vertical jump performance, peak anaerobic power (PAP.w), and the power-to-body mass ratio (P:BM) between individuals with ectomorphic-mesomorph and mesomorphic-ectomorph somatotypes. No statistically significant differences were found between somatotype groups for any of the performance indicators based on the reported p-values (all $p > .05$). Specifically, vertical jump means were 54.47 cm (±8.33) for the ectomorphic-mesomorph group and 57.09 cm (±6.28) for the mesomorphic-ectomorph group, yielding a non-significant p-value of .25. Similarly, PAP.w displayed means of 3576 W (±542.01) versus 3473 W (±538.71) for the ectomorphic-mesomorph and mesomorphic-ectomorph groups, respectively ($p = .64$). Finally, P:BM exhibited means of 69.97 W/kg (±10.51) for those with ectomorphic-mesomorph somatotypes compared to 65.10 W/kg (±7.46) for mesomorphic-ectomorphs ($p = .18$). While descriptive raw scores showed slight advantages for the ectomorphic-mesomorph group in vertical jump and PAP.w, these differences were not statistically significant based on the p-values reported. Overall, this initial study gave an insight on how somatotypes may relates to physical capabilities in the general population.

Conclusion

The current study found no significant differences in vertical jump, peak anaerobic power or relative anaerobic capabilities between ectomorphic-mesomorph and mesomorphic-ectomorph somatotypes. The study had a relatively small sample size of only 26 participants. With low statistical power from the limited participants, small true effects may go undetected as significant. Replication with larger samples would clarify if meaningful performance differences manifest between these somatotype groups. The participants were also sedentary and untrained. Comparing athletes that have undergone sport-specific training may reveal impacts of somatotype that are obscured in non-athletes. Future studies should implement matched randomized controlled trials tracking performance changes from a baseline over a training intervention. This would isolate the direct effects of somatotype on trainability and neuromuscular adaptations over time. Expanding sample diversity in factors like age, sex, ethnicity, and sport background could identify potential subgroup trends. Yet, further research with larger, matched samples is still needed to clarify the potential interacting effects of somatotype and body composition on sport performance capacities.

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Data availability

Full access to data on request.

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Conflicts of Interest

The Authors have no conflict of interest to declare

Informed Consent Statement

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

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