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Anthropometric Somatotype of Indian Combat Sports and Track and Field Athletes: A Systematic Review

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Resumen

Introducción: La utilización del somatotipo antropométrico es prevalente en el deporte. Es ampliamente aceptado el reconocimiento de un prototipo físico compartido y su vínculo con el rendimiento deportivo en los deportistas. Por lo tanto, es crucial explorar este aspecto entre los atletas indios. El estudio intentó recopilar y analizar sistemáticamente la literatura publicada existente que cubre el período comprendido entre 2003 y junio de 2023, enfatizando particularmente la somatotipificación de los atletas indios que participan en deportes de combate y eventos de atletismo. Además, se hicieron esfuerzos para evaluar los logros destacados y las limitaciones evidentes en los trabajos publicados durante el período especificado. **Métodos:** Los estudios publicados se recopilaron de varias bases de datos académicas, a saber, Google Scholar, PubMed, Scopus, SCISPASE y Semantic Scholar. Se redactaron criterios de inclusión y exclusión apropiados y los estudios se seleccionaron en consecuencia. Las categorías de somatotipo de los estudios individuales se calcularon y representaron en los diagramas de somatograma siguiendo el método de Carter. **Resultados:** Se consideraron adecuados para su inclusión en esta revisión dieciséis estudios que incluyeron a 887 atletas (746 hombres y 141 mujeres). El subgrupo de deportes de combate estuvo integrado por 361 atletas y el subgrupo de atletismo, por 526 atletas. Los luchadores exhibieron los niveles más altos de endomorfia y mesomorfia en los deportes de combate, mientras que los boxeadores junior mostraron la ectomorfia más alta. En atletismo, los lanzadores de martillo demostraron la mayor endomorfia, los lanzadores de peso exhibieron la mayor mesomorfia y la mayor ectomorfia caracterizó a los saltadores de altura. **Conclusión:** Las cartas somatográficas resaltan un prototipo físico compartido entre atletas dentro del mismo deporte, particularmente evidente en las pruebas de lucha libre, lanzamiento de martillo, lanzamiento de peso y salto. Sin embargo, la investigación sobre deportes de combate respalda los estudios en atletismo. La escasez de investigaciones sobre somatotipado entre atletas de élite y atletas femeninas de la India, junto con una deficiencia en los enfoques interdisciplinarios en los estudios de cineantropometría en la India, subraya la necesidad de intensificar las investigaciones integradoras.

Palabras Clave: Somatotipo, Atletas indios, Deportes de combate, Pruebas de atletismo

Abstract

Introduction: The utilization of anthropometric somatotyping is prevalent in sports. Recognizing a shared physical prototype and its link to athletic performance in athletes is widely accepted. Therefore, it is crucial to explore this aspect among Indian athletes. The study attempted to systematically collect and analyse existing published literature covering the timeframe from 2003 to June 2023, particularly emphasizing the somatotyping of Indian athletes engaged in combat sports and track and field events. Additionally, efforts were made to assess the prominent accomplishments and constraints evident in the published works during the specified period. **Methods**: Published studies were collected from various academic databases *viz.,* Google Scholar, PubMed, Scopus, SCISPASE, and Semantic Scholar. Appropriate inclusion and exclusion criteria were drafted, and the studies were selected accordingly. Somatotype categories of individual studies were computed and plotted in the somatocharts following Carter's method. **Results**: Sixteen studies comprising 887 athletes (746 males and 141 females) were deemed suitable for inclusion in this review. The combat sports subgroup constituted 361 athletes, and the track and field subgroup comprised 526 athletes. Wrestlers exhibited the highest levels of endomorphy and mesomorphy in combat

sports, while junior boxers displayed the highest ectomorphy. In track and field, hammer throwers demonstrated the highest endomorphy, shot putters exhibited the greatest mesomorphy, and the highest ectomorphy characterized high jumpers. **Conclusion**: The somatocharts highlight a shared physical prototype among athletes within the same sport, notably evident in wrestling, hammer throw, shot put, and jump events. However, research on combat sports trails behind studies in track and field. The scarcity of research on somatotyping among Indian elite athletes and female athletes, coupled with a deficiency in interdisciplinary approaches in kinanthropometry studies in India, underscores the need for heightened integrative investigations.

Keywords: Somatotype, Indian athletes, Combat sports, Track and field events.

Introduction

The morphological characteristics of athletes hold significance for human biologists, as competitive sports necessitate optimal performance from the body and therefore, it is reasonable to anticipate that athletes would exemplify the intricate interplay between structure and function (Carter 1970). Somatotype, a method for quantifying human body shape and size, has gained extensive traction in the field of sports science. This approach entails a meticulous and scientific categorization of the human body, employing individual body composition and structure as fundamental criteria. Anthropometric somatotyping employs a three-number rating scale, with each number corresponding to endomorphy (relative fatness), mesomorphy (relative musculoskeletal robustness), and ectomorphy (relative linearity or slenderness) in a consistent sequence (Carter 2002).

There exists significant evidence indicating a correlation between an individual's somatotype and their sports performance. The somatotyping analysis of athletes unveils a discernible physical prototype that endures across diverse age brackets and competitive tiers. This information proves invaluable for coaches during selection processes, aiding in talent identification within clubs, as well as regional and national teams (Bacciotti et al. 2018). Furthermore, the physique of an individual is influenced by various factors, including age (Lohe et al. 2021; Tsukru and Dkhar 2021), gender (Rhetso & Malik, 2018; Biljana et al. 2016), ethnicity (Biljana et al. 2016), dietary patterns (Kharil-Shazim et al. 2021), level of physical activity (Chandel et al. 2018), socio-economic status (Pelin et al. 2010), and geographical locations. Therefore, gaining insights into somatotypes offers a comprehensive understanding of an athlete's growth patterns, health, physical performance, adaptability to the environment, impacts of diet and training on the body, and the roles of genetics and bio-social factors in shaping body physique.

One of the classical reviews on somatotypes of athletes was done by Carter (1970), where the author presented a systematic report on male and female athletes of 14 different sports disciplines. More recently, various researchers have undertaken short reviews, systematic reviews, and meta-analyses on the somatotypes of athletes in diverse fields. For instance, Rakovick et al. (2015) gave a systematic analysis of elite athletes' somatotype, Sterkowicz-Przybycien et al. (2012) focussed on judokas, Sterkowicz-Przybycien and Gualdi-Russo (2019) reported a metanalysis on gymnasts, while Pena-Sanchez et al. (2022) conducted a systematic review explicitly addressing on somatotypes of taekwondo players.

Since the advent of anthropometric somatotyping, many influential studies have been conducted within the realm of Indian athlete assessment. Noteworthy contributions to the global landscape of kinanthropometry research have emerged from studies conducted by De and Debnath (1983) focusing on long-distance swimmers, Sodhi (1980, 1983) examining basketball players and wrestlers, Dey et al. (1993) and Khanna et al. (1996) exploring the physique of kabaddi players, Bandyopadhyay (2007) investigating soccer and volleyball players, and more recently, Adhikari and Chakrabarti (2022) looked into the somatotypes of Indian female rowers.

Considering these perspectives, and recognizing the significance of kinanthropometry research in the realm of sports performance, this paper attempts to conduct a comprehensive review of the somatotypes of Indian athletes participating in combat sports and track and field events.

Materials and Methods

This paper is a systematic literature review focusing on the somatotype characteristics of Indian athletes participating in combat sports and track and field events. The study encompasses research publications addressing this overarching theme within the time frame spanning from 2003 to June 2023.

Search strategies

Literatures were collected from various databases *viz*., Google Scholar, PubMed, Scopus, SCISPASE, and Semantic Scholar. Documentary search was done using a combination of various keywords. The keywords are

'somatotype', 'body physique', 'anthropometric characteristics', 'body composition', 'Indian athletes', 'combat sports', 'track and field', 'boxing', 'wrestling', 'judo', 'karate', 'wushu', 'taekwondo', 'runners', 'throwers', 'jumpers'.

Inclusion and exclusion criteria for selection of studies

In the context of this research, specific criteria were established to guide the selection and screening of relevant studies. The inclusion criteria were as follows:

1. Studies that exclusively employed the Heath and Carter method (1967) for anthropometric somatotyping were considered for inclusion in this analysis.
2. Inclusion was limited to studies that provided somatotype data on Indian athletes participating in combat sports and track and field events.
3. Only studies with accessible and complete full-text versions were eligible for inclusion in the review.

Conversely, the exclusion criteria were defined as follows:

1. Studies reporting somatotype data on athletes from sports disciplines other than combat sports and track and field events were excluded from consideration.
2. Studies lacking specification of the gender and age of the athletes were excluded.
3. Short communications, review papers, and case reports were excluded from the analysis.

Data extraction

Following an exhaustive examination of the literatures for this review, we systematically compiled relevant data from the chosen research articles and meticulously recorded it in an Excel spreadsheet. The extracted data encompasses various vital parameters, *viz.*, authors details, title, publication year, sports discipline, study groups/division (if applicable), demographic information such as age and gender, sample size, athletic proficiency level, anthropometric measurements including stature (cm) and weight (kg), as well as the components of endomorphy, mesomorphy, and ectomorphy.

Analysis

For plotting of somatocharts, the x- and y-coordinates of each discipline were calculated using the formula given by Carter (2002)

1. *x*-coordinate = Ectomorphy – Endomorphy
2. *y*-coordinate = 2 × Mesomorphy – (Endomorphy + Ectomorphy)

Utilizing the component dominance method outlined by Carter (2002), the individual studies were categorized into distinct groups. The resultant selection of studies was subsequently plotted on the somatochart. Additionally, the mean somatotypes corresponding to each sports discipline were calculated and illustrated to enhance the visual clarity of the presentation.

Results

The methodical procedure employed for the selection of studies included in this review is illustrated in Figure 1. Following a thorough screening and examination, a total of 16 studies have met the criteria for inclusion in the final evaluation.

The characteristics of these studies, categorized by gender and sports discipline, are presented in Table 1. In aggregate, the review encompasses combat sport and track and field athletes, with a cohort comprising 746 males and 141 females. Among the selected studies, 10 have reported on the anthropometric somatotyping of Indian track and field athletes, while 7 have focused on combat sport athletes. Notably, within the given time frame, no available literature has been identified pertaining to the somatotypes of Indian athletes engaged in wushu, karate, and taekwondo, to the best of our knowledge.

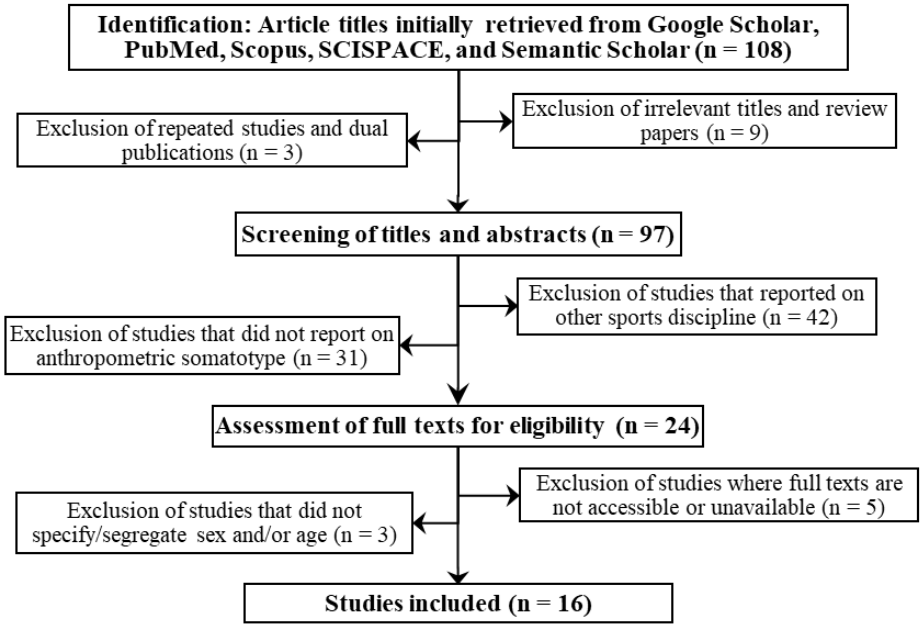

Figure 1: Study selection flow chart

Table 1. Characteristics of the studies selected according to sports discipline

Sports discipline		Number of studies	Sample size		
			Male	Female	Male + Female
Combat sports	Wrestlers	5	142	34	176
	Boxers	3	95	40	135
	Judokas	1	0	25	25
	Combat	2	25	0	25
	Total	*7**	*262*	*99*	*361*
Track and field events	Runners	3	94	0	94
	Throwers	6	204	30	234
	Jumpers	3	160	0	160
	Athletics	2	26	12	38
	Total	*10**	*484*	*42*	*526*
Overall total		*16**	*746*	*141*	*887*

Figure legend: * - after adjusting for studies that reported on more than one sport discipline

Combat Sport Athletes

Table 2 details the contextual specifics of studies and somatotypes related to Indian combat athletes. Choudhary et al. (2019) found that mesomorphy levels were highest in wrestlers, while heavyweight Greco-Roman wrestlers (Neogi et al. 2019) displayed the highest endomorphy. It is worth noting that there was significant diversity among wrestlers in terms of ectomorphy, with Naga wrestlers (Tsukru et al. 2021) recording the lowest scores.

In the context of boxing, both elite and senior boxers exhibited elevated mesomorphy ratings in comparison to their national and junior counterparts, as outlined in Table 2. Specifically, heavyweight elite boxers (Singh et al. 2023) recorded the highest mesomorphy component, while junior boxers (Khanna & Manna, 2006) displayed the lowest. Singh et al. (2023) reported notable somatotype variations among lightweight, middleweight, and heavyweight elite boxers. Additionally, when considering all male-focused studies, Armendariz et al. (2023) found that endomorphy levels were highest among female boxers.

Table 2. Somatotype characteristics of Indian combat sports athletes

Source	Division/ class	Sex	Age mean/ group	Level	N	Endo	Meso	Ecto	Somatotype category
Wrestlers									
1	-	M	17.1	State	32	3.50	4.90	1.60	Endomorphic mesomorph
2	HW	M	16.2	Elite	9	4.30	5.00	2.60	Endomorphic mesomorph
	LW	M	16.4	Elite	19	4.10	5.20	2.20	Endomorphic mesomorph
3	-	F	18.3	NAT	34	3.54	4.86	1.74	Endomorphic mesomorph
7	-	M	19.77	NAT	30	3.18	6.00	1.22	Endomorphic mesomorph
4	-	M	18-34	State	52	4.15	5.13	1.18	Endomorphic mesomorph
Boxers									
5	Junior	M	17.6	NAT	30	1.80	3.20	4.00	Mesomorphic ectomorph
	Senior	M	22.1	NAT	30	2.30	4.90	2.30	Balanced mesomorph
3	-	F	18.56	NAT	40	3.57	3.82	2.45	Endomorphic mesomorph
6	LW	M	22.7	Elite	16	1.70	4.30	3.70	Ectomorphic mesomorph
	MW	M	24	Elite	8	2.50	5.20	2.70	Balanced mesomorph
	HW	M	23.7	Elite	11	3.00	5.70	1.90	Endomorphic mesomorph
	Combined	M	23.3	Elite	35	2.30	4.90	2.90	Ectomorphic mesomorph
Judokas and combat athletes									
3	Judokas	F	18.5	NAT	25	3.73	4.94	1.70	Endomorphic mesomorph
7	Combat	M	19.5	NAT	25	2.76	3.99	2.89	Balanced mesomorph

Figure legends: M – Male; F – Female; N – Number of samples; NAT – National; HW – Heavyweight; MW – Middleweight; LW – Lowweight

Sources: 1 = Madhvan 2013; 2 = Neogi et al. 2019; 3 = Armendariz et al. 2023; 4 =Tsukru et al. 2021; 5 = Khanna and Manna 2006; 6 = Singh et al. 2023; 7 = Choudhary et al. 2019

A recent study by Armendariz et al. (2023) exclusively reported on the somatotypes of Indian judokas. The mean somatotype for female judokas was identified as 3.73 – 4.94 – 1.70, classifying them as endomorphic mesomorphs. However, comprehensive comparisons involving factors such as gender, weight class, and age could not be undertaken due to the absence of pertinent data. Conversely, Choudhary et al. (2019) reported on combat sports athletes without specifying or segregating the particular combat discipline.

Track and Field Athletes

Table 3 outlines the key attributes of studies and somatotypes concerning Indian athletes participating in track and field events. Among runners, studies by Singh and Sharma (2019) and Shafeeq et al. (2010) revealed that sprinters displayed the highest mesomorphy values in their somatotype ratings. It's noteworthy that, in comparison to sprinters, middle-distance and long-distance runners (Shafeeq et al. 2010) exhibited higher endomorphy ratings, with long-distance runners registering the highest ectomorphy ratings.

In the domain of throwing events, hammer throwers (Singh 2017), shot putters (Singh K et al. 2012), and low-performing hammer throwers (Singh S et al. 2012) reported the highest levels of endomorphy, mesomorphy, and ectomorphy, respectively.

In jumps, low-performing high jumpers (Singh S et al. 2010) displayed the highest ratings in both endomorphy and ectomorphy when compared to other jump disciplines. In contrast, elite long jumpers examined by Singh S et al.

(2010) exhibited the highest levels of mesomorphy. Additionally, Shafeeq et al. (2010) and Kumar (2015) provided general somatotype information for throwers and jumpers without specifying the types of throw events.

Table 3. Somatotype characteristics of Indian track and field athletes

Source	Division/ class	Sex	Age mean/ group	Level	N	Endo	Meso	Ecto	Somatotype category
Runners									
8	Sprinters	M	Senior	NAT	12	2.66	4.66	1.83	Endomorphic mesomorph
9	Sprinters	M	19.5	State	22	2.53	4.31	3.06	Ectomorphic mesomorph
	MD	M	19.0	State	16	2.81	3.96	3.31	Ectomorphic mesomorph
	LD	M	18.1	State	20	2.60	3.72	3.56	Mesomorph-ectomorph
10	Runners	M	18-25	AIU	24	2.46	1.61	3.25	Endomorphic ectomorph
Throwers									
11	HT	M	18-26	AIU	10	4.61	5.04	0.75	Endomorphic mesomorph
12	HT (GP 1)	F	18.33	Elite	6	4.17	2.51	2.20	Balanced endomorph
	HT (GP 2)	F	19.67	Elite	6	5.77	4.37	0.77	Mesomorphic endomorph
	HT (GP 3)	F	21.0	Elite	5	4.88	3.14	1.34	Mesomorphic endomorph
	HT (GP 4)	F	21.4	Elite	5	4.35	2.77	1.19	Mesomorphic endomorph
	HT (GP 5)	F	21.75	Elite	8	3.69	3.19	0.95	Mesomorph-Endomorph
13	HT	M	Senior	Elite	25	4.17	2.40	0.88	Mesomorphic endomorph
	Shot put	M	Senior	Elite	25	4.53	5.04	0.59	Endomorphic mesomorph
14	Shot put (HP)	M	18-25	AIU	10	4.84	5.10	0.66	Endomorphic mesomorph
	Shot put (LP)	M	18-25	AIU	10	5.13	5.00	0.59	Endomorphic mesomorph
11	Shot put	M	18-25	AIU	10	4.84	5.10	0.66	Endomorphic mesomorph
13	Javelin throw	M	Senior	Elite	25	3.28	2.35	1.72	Mesomorphic endomorph
11	Javelin throw	M	18-27	AIU	10	4.13	4.34	1.51	Ectomorphic endomorph
	Discus throw	M	18-28	AIU	10	4.65	4.98	0.86	Endomorphic mesomorph
13	Discus throw	M	Senior	Elite	25	4.08	2.53	1.30	Mesomorphic endomorph
10	Throwers	M	18-25	NAT	24	4.49	2.42	1.91	Balanced endomorph

9	Throwers	M	19	State	20	3.39	4.23	2.10	Endomorphic mesomorph
Throwers									
15	High jump (HP)	M	18-25	AIU	10	2.29	2.76	3.95	Mesomorphic ectomorph
	High jump (LP)	M	18-25	AIU	10	2.56	1.56	4.38	Endomorphic ectomorph
13	High jump	M	Senior	Elite	25	1.98	2.53	4.32	Mesomorphic ectomorph
	Long jump	M	Senior	Elite	25	2.03	3.68	2.55	Ectomorphic mesomorph
	Pole vault	M	Senior	Elite	25	2.03	3.63	2.84	Ectomorphic mesomorph
	Triple jump	M	Senior	Elite	25	1.94	3.80	3.13	Ectomorphic mesomorph
9	Jumpers	M	18.3	State	16	2.87	4.03	3.18	Balanced mesomorph
10	Jumpers	M	18-25	NAT	24	2.39	2.03	3.44	Endomorphic ectomorph
Athletics									
9	Athletics	M	19.64	NAT	26	2.40	4.38	2.74	Balanced mesomorph
16	Athletics	F	16-17	NAT	12	4.60	2.60	2.50	Ectomorphic endomorph

Figure legends: MD – Middle distance; LD – Long distance; HT – Hammer throwers; G1-G5 – Groups from low to high performers; HP – High performers; LP – Low performers; M – Male; F – Female; NAT – National; AIU – All India University; N – Number of samples

Sources: 8 = Singh and Sharma 2019; 9 = Shafeeq et al. 2010; 10 = Kumar 2015; 11 = Singh 2017; 12 = Singh S et al. 2012; 13 = Singh B et al. 2012; 14 = Singh K et al. 2012; 15 = Singh et al. 2010; 16 = Adhikari 2003; 9 = Choudhary et al. 2019.

Discussion

Perhaps this review constitutes one of the limited systematic examinations regarding the morphological attributes of Indian athletes. It attempts to systematically gather and scrutinize available published literature from 2003 to 2023, with a specific emphasis on the somatotyping of Indian athletes engaged in both combat sports and track and field events.

Very few studies on Indian female athletes have been reported and found qualified for this review (Table 1). In general, research on Indian female athletes has been relatively limited compared to their male counterparts. This discrepancy may be attributed to historical male dominance in sports which shaped research priorities and subject selection. Additionally, pervasive societal stereotypes regarding women's participation in sports in India have existed for a considerable period. However, it is crucial to note that contemporary times have witnessed significant shifts in these dynamics. Consequently, a multitude of recent studies focusing on the somatotyping of female athletes have been conducted and published by various researchers (Luthra et al. 2021; Alsapure 2021; Chakarbati and Adhikari 2023; Adhikari and Chakarbati 2023; Armendariz et al. 2023).

This discernible pattern of gender disparity in sports research is consistent with findings from a systematic review on gender inequalities in sports medicine research by Paul et al. (2023), who reported a similar imbalance between male and female subjects. Additional review articles on sports research by Shahidi et al. (2023) in ball sports and Pena-Sanchez et al. (2022) in taekwondo have also highlighted comparable patterns of gender disparity. Therefore, it is evident that this issue is not confined solely to India but is a global phenomenon. Paul et al. (2023) have identified potential factors contributing to this inequality, including financial and promotional incentives, a higher percentage of male researchers, and gender biases within the sports domain.

In wrestlers, there exists limited variability in the endomorphy and mesomorphy components, irrespective of variables such as age, gender, or competitive level. Significantly, all five studies examining the somatotypes of Indian wrestlers consistently reveal the prevalence of the endomorphic-mesomorph somatotype. The mean somatotype for Indian wrestlers in this review is 3.80 – 5.18 – 1.71, which is comparatively lower than the somatotype ratings reported for top-tier elite wrestlers whose somatotype is 1.80 – 6.70 – 1.10 (Sterkowicz-Przibycien et al. 2011). The somatoplots from individual studies, as well as their overall mean, predominantly cluster in the mesomorph section with minimal dispersion (see Figure 2). These findings suggest that the endomorphic-mesomorph somatotype is deemed suitable for national-level wrestling but may not be deemed optimal for the highest echelons of competition.

Further comprehensive studies, encompassing a broader spectrum of kinanthropometry considerations, including different weight categories and wrestling styles, are imperative to establish a more conclusive stance on the ideal somatotype for wrestlers.

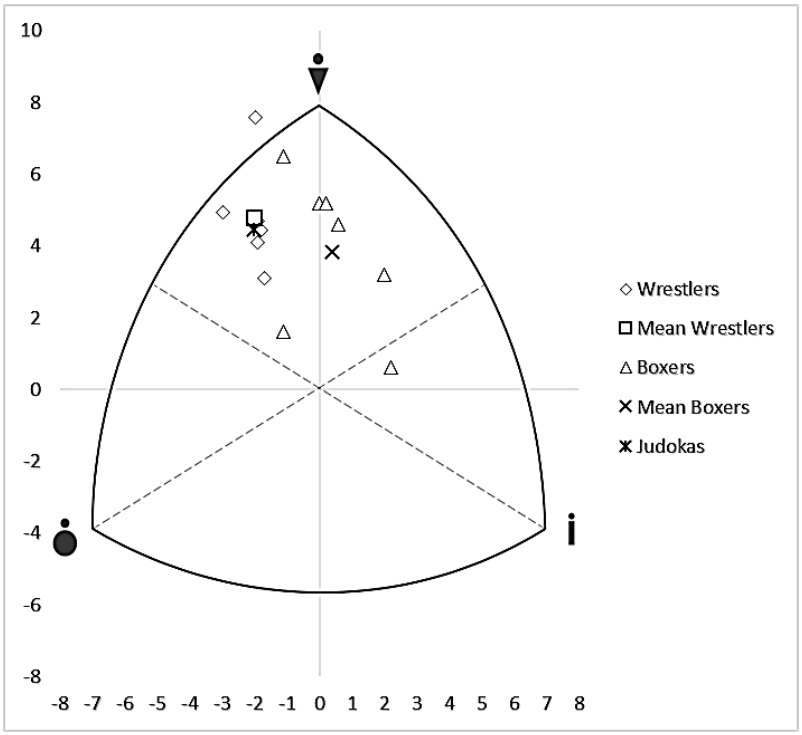

Figure 2. Somatochart of Indian combat sport athletes

Source: Wrestlers (Madhvan 2013; Neogi et al. 2019; Armendariz et al. 2023; Choudhary et al. 2019; Tsukru et al. 2021). Boxers: (Khanna & Manna, 2006; Armendariz et al. 2023; Singh et al. 2023). Judokas: (Armendariz et al. 2023)

In the case of elite boxers (Singh et al. 2023), there is a discernible inclination towards greater musculoskeletal development compared to their non-elite counterparts (Khanna & Manna, 2006; Armendariz et al. 2023). The mean somatotype for boxers in this review, derived from three studies, is 2.45 – 4.57 – 2.85, classifying them as balanced mesomorphs. This outcome aligns with the somatotypes reported for elite boxers by Noh et al. (2014). Notably, Indian boxers exhibit higher levels of muscularity and leanness in comparison to Turkish male wrestlers (Bal et al. 2021). The distribution of somatotypes among Indian boxers points towards a dominance in the mesomorphy and ectomorphy sub-categories. Also, the dispersion of somatotypes on the chart (Figure 2) is likely due to age groups, gender, and weight class divisions considered in the studies. However, the prevalent mesomorphy of boxers remains evident. Additionally, female judokas in India demonstrate lower muscularity and relative fatness in comparison to Colombian female judokas as studied by Quintero et al. (2019). The somatotype of Indian female judokas (Armendariz et al. 2023) closely corresponds with the mean somatotype of wrestlers as observed in the somatochart (refer to Figure 2).

An examination of Table 2 highlights that wrestlers demonstrate heightened muscularity and bulk in contrast to boxers and judokas. Conversely, boxers showcase greater leanness compared to wrestlers and judokas, as evident in their elevated ectomorphy values. Wrestlers and judokas tend to predominantly align with endomorphy and mesomorphy sub-categories, while boxers primarily belong to mesomorphy and ectomorphy subgroups. The dispersion of somatoplots emphasizes a clear physical differentiation in body physique between wrestlers and boxers.

The findings of this review reveal that sprinters among Indian runners exhibit the highest muscle mass, while long-distance runners tend to be the leanest. This observation highlights a discernible variation in body types across different running events, aligning with the specific physical demands of each game. Nevertheless, as a general trend, runners are predominantly classified within the sub-groups of mesomorphy and ectomorphy, indicating diversity in somatotype categories. The mean somatotype of Indian runners, as presented in this review, is 2.61 – 3.61 – 3.00, placing them in the balanced mesomorph category (refer to Figure 3). However, this rating falls below that of elite-level runners (Munoz et al. 2020), primarily due to the comparatively higher relative fatness and lesser muscle development observed in Indian runners when compared to those reported by Munoz et al. (2020).

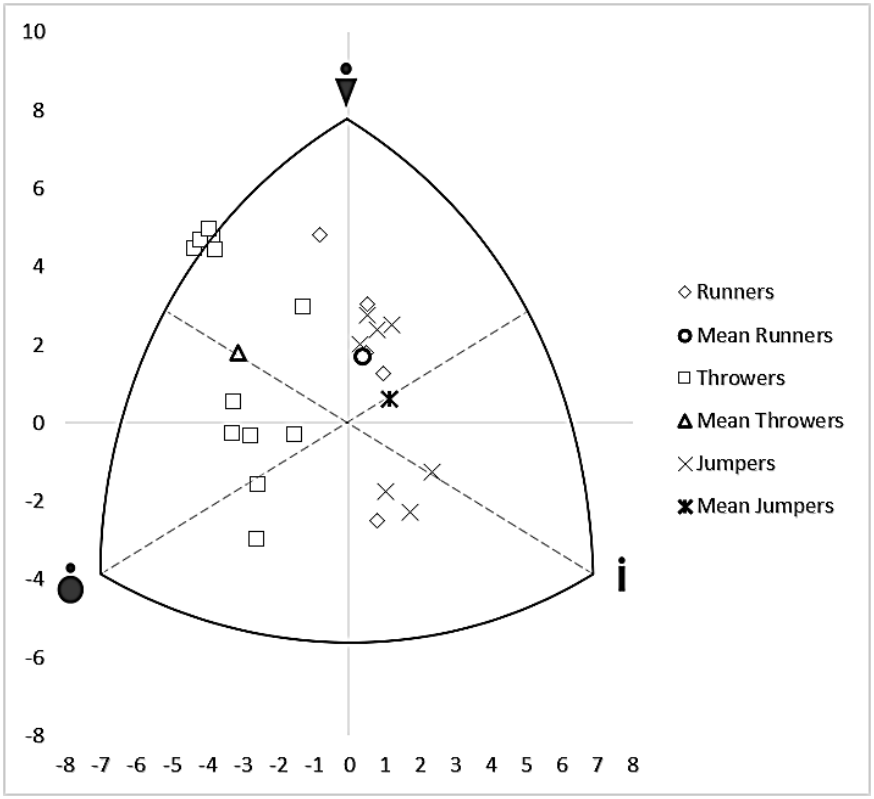

Figure 3. Somatochart of Indian track and field athletes

Source: Runners (Singh and Sharma 2019; Shafeeq et al. 2010; Kumar 2015). Throwers (Shafeeq et al. 2010; Kumar 2015; Singh et al. 2012; Singh et al. 2012). Jumpers (Shafeeq et al. 2010; Kumar 2015; Singh et al. 2010)

High jumpers (Singh et al. 2010, and Singh B et al. 2012) typically exhibit higher ectomorphy values compared to athletes participating in other jumping events, as detailed in Table 2. Events such as long jump, pole vault, and triple jump exhibit a more pronounced development of mesomorphy than the other two somatotype components.

This empirical evidence substantiates the existence of a distinct physical prototype among Indian athletes participating in jump events. The majority of jumpers predominantly fall within the subgroups characterized by mesomorphy and ectomorphy, as illustrated in Figure 3 Notably, only two studies (Kumar 2015; Singh et al. 2010) have identified endomorphic categories among jumpers. The mean somatotype of Indian jumpers considered in this review is 2.24 – 3.12 – 3.38, categorizing them within the mesomorph-ectomorph classification. Notably, there is minimal disparity in somatotypes across different jump events, suggesting a standard physique among jumpers. However, a comparison between elite (Singh B et al. 2012) and non-elite (Singh et al. 2010) jumpers reveals that a prevalence of ectomorph and mesomorph categories distinguishes elite jumpers.

Hammer throwers generally exhibit a predominance of endomorphy compared to other components, typically manifesting as a mesomorphic endomorph physique. Conversely, shot putters display a consistent body physique across the three studies included in this analysis (Singh 2017; Singh K et al. 2012; Singh B et al. 2012). The reported somatotype category for Indian shot putters, irrespective of competition level, is consistently characterized as endomorphic mesomorph. It is noteworthy that high-performing shot putters showcase higher mesomorphy and lower endomorphy in comparison to their less proficient counterparts (Singh S et al. 2012). At the elite level, javelin throwers (Singh B et al. 2012) are characterized by a mesomorphic endomorph somatotype, while university-level throwers (Singh 2017) exhibit an endomorphic mesomorph physique.

In contrast to the somatotype of Indian javelin throwers, Fares et al. (2020) reported lower endomorphy and higher mesomorphy among Algerian javelin throwers when compared to their Indian counterparts. Conversely, elite discus throwers (Singh B et al. 2012) demonstrate an endomorphic mesomorph somatotype, while university-level throwers (Singh 2017) exhibit an endomorphic mesomorph physique. Nevertheless, similar somatotype components are observed among discus throwers (Figure 3), indicating a predominant classification within the subcategories of endomorphy and mesomorphy. The mean somatotype of Indian throwers considered in this review is 4.13 – 3.64 –

1.16, placing them in the mesomorph-endomorph category. The somatotypes of Indian throwers exhibit variations across different types of throws, as evidenced by the somatotype ratings and classifications. Furthermore, endomorphy tends to be higher in female hammer throwers and female boxers compared to other male athletes in track and field events. This gender difference in adiposity-associated somatotype components aligns with findings in other sports disciplines (Peiter & Bercade 2009; Zuniga et al. 2011; Chakarbati & Adhikari, 2023).

Runners and jumpers predominantly fall within subgroups characterized by mesomorphy and ectomorphy (Figure 3). Notably, there is a considerable dispersion distance between studies, particularly in terms of runners. For throwers, the dispersion distance between somatoplots is also significant, primarily due to discus and javelin throwers exhibiting lesser endomorphy development compared to hammer throwers and shot putters. As depicted in Figure 3, the somatotype of each track and field event differs from the others. Despite this, there is a consensus among published works on the somatotype of Indian athletes included in the review, indicating a dispersion according to their sports discipline. Therefore, the presence of a common body type among Indian athletes is evident.

Within this review, a notable gap in research is evident, particularly concerning the investigation of elite Indian athletes. Specifically, only two studies have explored the somatotypic characteristics of elite throwers and jumpers, as evidenced by the works of Singh S et al. (2012) and Singh B et al. (2012). In the realm of combat sports, Neogi et al. (2019) conducted an investigation among elite wrestlers, while Singh et al. (2023) focused on elite boxers. The limited number of studies addressing elite athletes is notably non-aligning with the pivotal role of somatotypes in performance at the highest level of competition. The need for additional research on elite athletes in the country is vital because it will provide better biological and physiological insights which can help contribute in performance enhancement strategies, and the refinement of advanced training protocols.

Most investigations selected in this review have primarily documented and delineated only the athletes' physical characteristics. Only three investigations have explored the correlation between somatotype and sport-specific performance. In this line, Singh et al. (2012) conducted a study on shot putters, while Singh et al. (2012) and Singh et al. (2010) investigated the hammer throwers. However, these inquiries exclusively concentrated on the relationship with sport-specific performance. Notably, within the realms of combat sports and track and field events, no published study has explored the association of body physique with fitness, strength, agility, and performance variables beyond those directly tied to the specific sport. It is interesting to highlight that, in the context of combat disciplines, none of the studies included in this systematic review have examined the correlation between somatotype and sports performance. Consequently, contemporary researchers in the fields of sports science and sports medicine should prioritize a multidisciplinary approach involving experts from various domains within sports science to comprehensively enhance the overall athletic performance.

Conclusion

Within a given discipline, the physique varies across different events, shaped by the specific training, somatic demands, and dietary requirements of each sport. The dispersion of somatotypes on the somatochart highlights the existence of a shared physique among athletes specializing in specific fields. This common prototype is particularly prominent among wrestlers, hammer throwers, shot putters, and jumpers. Unlike the wealth of research in track and field, there is a relative scarcity of studies in combat sports. Over the past decade, there has been a noteworthy increase in somatotyping investigations involving Indian athletes, signalling a positive shift toward a deeper comprehension of body types and athletic performance. Nevertheless, there is still a scarcity of literature on the somatotypes of Indian elite athletes, and female athletes. Consequently, this review emphasizes the urgent necessity for improved sports science research in India, stressing the importance of adopting a multidisciplinary approach.

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