

Characterization of the Somatotype in Taekwondo: Systematic Review

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Abstract: The Taekwondo, as in other sports, athletes who have certain physical characteristics have an advantage over their opponents, in this sense, success in the practice of taekwondo requires certain types of physical, physiological, psychological and social capacities, so those athletes whose characteristics anthropometric are favorable to them, they may be benefited over others. This is why we set ourselves the objective of reviewing the information regarding the somatotype presented by athletes who practice taekwondo. A Systematic Review of the databases "PubMed", "SportDiscus", "Scopus", "ScienceDirect", "ProQuest", "Dialnet" and "SciELO" was carried out using in the search criteria Boolean operators and keywords of the following way: ("taekwondo" OR "karate" OR "martial arts" OR "judo" OR "mixed martial arts") AND ("somatotype" OR "body composition" OR "anthropometry"). A total of 15 works were obtained to carry out the analysis, the total sample of these studies adds up to 826 athletes, with a mean age of 20.4 ± 1.76 years. Varied results were found, depending on the competitive level, the country and the weight category, but there was a certain trend towards outstanding values of the mesomorphic component and of the ectomorphy in men, in contrast, for the female sex, although fewer studies were found to analyze, a trend towards a central somatotypic classification was evidenced. The study of body composition and somatotype is just one of the many factors to take into account when carrying out the analysis of an athlete or a group of athletes, however, this may be the starting point to be able to identify potential talents in this sport.

Keywords: Anthropometry, Body Composition, Martial Arts

1. Introduction

Taekwondo is a Korean martial art form, originally designed for warfare and self-defense, which in its development was influenced by Japanese and Chinese martial arts, both directly and indirectly [1]. Its translation literally means "art of fighting with feet and hands." Taekwondo is a unique sport, due to the predominant use of powerful kicking techniques [2]. The popularity of taekwondo was growing around the world and as a result of its evolution, it changed its martial character to a competitive character. This also paved the way for taekwondo to become an internationally recognized sport [3] to the point that it became an Olympic sport at the 2000 Sydney Olympics.

Taekwondo matches take place in 3 rounds of 2 minutes

each, with 1 minute rest between each round. Due to these competitive characteristics, the performance of taekwondo athletes depends primarily on alactic anaerobic power, agility, aerobic power [4], explosiveness, general motor coordination [5], and explosive power of the lower extremities [6]. In this way, taekwondo training has been found to be associated with improvements in anaerobic fitness, fat reduction, improved flexibility [7], positive effects on isokinetic muscle strength and endurance [8]. On the other hand, athletes show high levels of emotional intelligence, a healthy body image [9, 10], personal improvement in self-control and improvement of cognitive functioning [10].

Taekwondo, like other combat sports, is regulated by weight divisions for combat, this makes athletes have to control their body weight during the training process and before competition. A survey applied to English national and

international taekwondo players, revealed that 87% of respondents tried to lose weight before the competition to give the weight of the classification [11]. This is probably due to the fact that during the training process the athletes present a slightly higher weight than their competition category, which is characteristic of this type of sports [12]. In this sense, several studies have been published about the body composition of athletes who practice taekwondo, concluding that at a general level international athletes have low levels of body fat [13-15], moderate skeletal muscle tissue, relative linearity of the body [13] and low body mass indexes [14, 15].

Therefore, the above shows that in general, the best athletes are slimmer and that body structure has a positive influence on the level of performance in taekwondo [16]. In addition to this, it has been possible to demonstrate a propensity for lean mass of the lower extremities, in relation to the lean mass of the upper part of the body [14], therefore, levels of force similar to skaters have been found [17-19].

Success in any sport requires certain types of physical, physiological, psychological and social capacities [20], so those athletes whose anthropometric characteristics are favorable to them may benefit from others [21].

A clear example in taekwondo is that taller athletes, having longer upper and lower limbs, provide them with a greater ability to cover a larger area with less energy, by having longer lever arms [17]. Likewise, the physical can be used as a selection criterion to detect and develop talents in taekwondo [22]. Therefore, understanding the differences in morphological optimization between combat sports is important for talent identification and transfer initiatives [14].

Anthropometric information, physical performance and motor coordination profiles of elite level athletes are of great importance for coaches, since these can be used as a reference to plan training programs, to distinguish their athletes according to their data [5] and for the evaluation of the athlete [23]. This is why it is important to know what the somatotype of athletes who practice taekwondo should be. So, in order to answer this question, for the development of this work we set ourselves the objective of reviewing the information regarding the somatotype of the athletes who practice this sport.

2. Materials and Methods

In preparing this manuscript, the recommendations described in the PRISMA-P [24] and QUORUM [25] statements for the construction of standardized reports of systematic reviews were followed.

Taking into account that Bridge et al 2014 [13] carried out a systematic review of the physical and physiological profiles of taekwondo athletes from 2013 onwards, in order not to replicate the information found by these authors, it was established to perform a search for bibliographic information limiting the results to works published as of 2014. Additionally, this search was complemented with a manual inspection of the references of the articles found in the first

instance, in order to locate additional information that coincides with the topic study. The documentary databases selected for the English language search were "PubMed", "SportDiscus", "Scopus", "ScienceDirect" and "ProQuest". On the other hand, to carry out the search in Spanish, the databases "Dialnet" and "SciELO" were selected.

The terms used for the documentary search are a combination of keywords, as well as an addition of other martial arts to encompass similar studies in other sports, in order to be able to make a comparison of the somatotypes with these sports disciplines and taekwondo. For this, the Boolean operators were used as follows: ("taekwondo" OR "karate" OR "martial arts" OR "judo" OR "mixed martial arts") AND ("somatotype" OR "body composition" OR "anthropometry").

The selection criteria of the articles were: publications in English, Spanish or Portuguese, studies with the objective of reporting the result of the somatotype components of recreational, university, regional competitive, national competitive or elite athletes, clearly reporting the study population and age of the participants. Articles that were not related to this objective, that presented ambiguity in the information, in the methods or in the protocols used, were also excluded, documentary reviews, expert opinions, opinion articles and conference proceedings were not taken into account, giving as a final result a total of 15 studies that finally formed part of the present review (Figure 1).

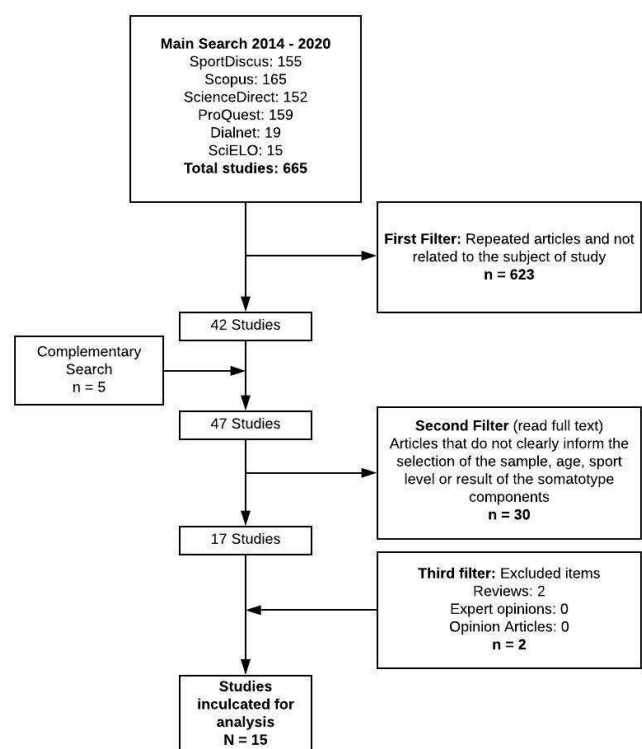


Figure 1. Study selection process.

The quality of the evidence was assessed through the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) system. In the GRADE system, the quality of evidence is initially classified as high or low,

depending on whether it comes from experimental or observational studies. The strength of the recommendations is based not only on the quality of the evidence, but also on a series of factors such as the balance between risks and benefits, the values and preferences of patients and professionals, as well as the consumption of resources or costs [26].

The information from each study taken into account for this review was: sample size, sex, age, country, competitive level, weight division, endomorphy result, mesomorphy and ectomorphy.

3. Results

A total of 15 works were obtained to carry out the analysis, where the authors carried out somatotype studies of athletes who practice taekwondo from a training level, to international elite competitors. In total, the population of these studies totals 826 athletes (Table 1), with a mean age of 20.4 ± 1.76 years, divided into 625 men with a mean age of 20.6 ± 2.04 years and 201 women with a mean age of 20.4 ± 1.03 years.

Table 1. Characteristics of the sample.

	n	Age				Endomorphy				Mesomorphy				Ectomorphy			
		Min	Max	Media	SD	Min	Max	Media	SD	Min	Max	Media	SD	Min	Max	Media	SD
Men	625	15,6	24,7	20,6	2,04	1,4	4,3	2,3	0,72	2,3	6,1	3,8	1,04	1,1	5,8	3	0,91
Women	201	18,5	21,7	20,4	1,03	1,4	5,13	3,1	1,15	1,81	4,6	3,4	0,78	1,8	5	2,7	0,97

N: sample; Min: Minimum; Max: Maximum; Average: Arithmetic Average; SD: Standard deviation.

Table 2 shows the description of the somatotype of the male population in 32 types of athletes carried out in 14 different studies. In this sense, it can be observed that the results for the 3 components of the somatotype are quite varied, there is not a marked predominance of any. On the one hand, the levels of endomorphy are very different,

with low results as seen in the Spanish team in the 58 and 68 kg divisions, as well as the Turkish 80 kg team; However, and in contrast to the above, it is relevant to mention that, in this sense, it was particularly evident that in Korean athletes of 95 - 114 kg the level of endomorphy is considerably high.

Table 2. Somatotype of male athletes who practice taekwondo.

category	Age	SD	n	EN	SD	ME	SD	EC	SD	Somatotype	Reference
Turkey national team ≤ 58 kg	19,6	3	16	1,4	0,3	2,8	1,4	5,8	0,8	Meso-Ectomorph	(Revan et al., 2018)
Turkey national team 58-68 kg	20,9	3,1	16	1,5	0,4	3,4	1,1	4,6	1,2	Meso-Ectomorph	
Turkey national team 68-80 kg	22,1	3,5	19	1,8	0,5	3,8	1,5	3,8	1,2	Mesomorph-Ectomorph	
Turkey national team ≥ 80 kg	24,7	4,8	11	2,1	0,3	4,6	1,6	2,7	0,7	Ecto-Mesomorph	
Regional competitive Chile	18,8	2,6	4	2,5	1,1	4,1	0,7	3	0,8	Balanced Mesomorph	(Orellana Lepe et al., 2018)
			19	2,2	0,1	2,6	0,2	3,6	0,2	Balanced Ectomorph	
Korea elite 55-74 kg	19,6	0,6	11	2	0,2	2,7	0,2	2,9	0,2	Central	(Ji-Wong Noh et al., 2018)
			1	4,3	0,3	3	1,2	1,1	0,4	Meso-Endomorph	
Korea elite 75-94 kg			17	2,2	0,1	2,7	1,9	2,8	0,2	Central	
Korea elite 95-114 kg	19,8	0,3	3	3,7	0,2	3,5	0,8	1,5	0,5	Mesomorph-Endomorph	(do Kim et al., 2018)
			37	3,7	0,9	3,2	0,9	2,6	1,0	Mesomorph-Endomorph	
Korea elite mode poomsae 55-74 kg	20,1	2,0	12	2,9	1,3	2,4	1,0	3,4	1,0	Central	
	23	5	16	3,7	1,5	4,9	1,2	3	1,1	Endo-Mesomorph	(da Silva Santos et al., 2018)
Korea elite mode poomsae 75-94 kg	21,4	1,7	40	2,3	0,9	5,3	1,2	2,5		Balanced Mesomorph	(Burdukiewicz et al., 2018)
	22,4	4,2	27	1,7	0,3	3,8	1,5	3,8	1,2	Mesomorph-Ectomorph	(Revan et al., 2017)
Philippines national university *	21	3,2	35	1,7	0,5	3,4	1,5	4,3	1,4	Meso-Ectomorph	
	21,3	3	50	3,5	0,9	4,6	1,2	2,8	1,2	Endo-Mesomorph	(Shariat et al., 2017)
Philippines national university **	20,3	3,1	36	1,7	0,7	3,9	1	3,6	1,1	Ecto-Mesomorph	(Pons et al., 2015)
Regional competitive Brazil	22,4	4,4	35	1,8	0,6	4,3	0,9	3,3	0,7	Ecto-Mesomorph	
University Poland	21,2	4	28	2,2	0,8	4,5	1	2,9	1,2	Ecto-Mesomorph	
Turkey national team	19,7	3,4	20	3	1,5	5,5	1,3	1,9	1,1	Endo-Mesomorph	(Godoy-Cumillaf et al., 2015)
Foreign national team	15,6	2,7	4	2,7	0,9	5	0,8	2,3	0,9	Balanced Mesomorph	
Iran national			7	2,1	0,2	2,7	0,2	3,9	0,3	Meso-Ectomorph	(J. W. Noh et al., 2013)
Spain national team < 58 kg			12	2,3	0,2	2,3	0,3	3,4	0,3	Balanced Ectomorph	
Spain national team < 68 kg	19,7	0,2	9	1,9	0,2	3,1	0,2	3,1	0,2	Mesomorph-Ectomorph	(Catikkas et al., 2013)
Spain national team < 80 kg			3	2,9	0,7	2,8	0,6	1,9	0,5	Mesomorph-Endomorph	
Spain national team > 80 kg			20	2,4	0,2	2,8	0,2	2,6	0,2	Central	(Campos et al., 2012)
Chile training	20,3	3,2	48	2,9	1,3	4,3	1,3	3,1	1,3	Balanced Mesomorph	
Korea elite < 58 kg	20	6,3	17	2,7	1,4	4	1,5	2,2	1,5	Balanced Mesomorph	

n: Sample; SD: Standard deviation; EN: Endomorphy; ME: Mesomorphy; EC: Ectomorphy *Winner, **Non-winner.

Regarding the levels of mesomorphy, the trend is the presence of high levels of this component in general. This seems to be the component of the somatotype, which, although it varies according to each study, presents a certain

predominance over the others. Finally, the results of the component of the ectomorphy varied, in general, the taekwondo players of the higher weight categories, present lower levels in this component of the somatotype.

Table 3 shows the description of the somatotype for the female sex, in this table, 13 samples from 6 research works can be seen, which denotes a lower number of samples and investigations, in relation to the results of men. This may be

due to a lower number of female athletes practicing taekwondo, or failing that, to a lower interest of researchers in working with this population.

Table 3. *Somatotype of female athletes who practice taekwondo.*

Nivel	Age	SD	n	EN	SD	ME	SD	EC	SD	Somatotype	Reference
Turkey national team ≤49 kg	19	2	6	1,4	0,3	2,8	1,4	5	0,8	Meso-Ectomorph	(Revan et al., 2018)
Turkey national team 49-57 kg	20,3	2,1	8	1,5	0,4	3,4	1,1	4,6	1,2	Meso-Ectomorph	
Turkey national team 57-67 kg	20,5	2,4	12	1,8	0,5	3,8	1,5	3,8	1,2	Mesomorph-Ectomorph	
Turkey national team ≥67 kg	19,4	1,8	5	2,1	0,3	4,6	1,6	2,7	0,7	Ecto-Mesomorph	
Regional competitive Chile	18,5	1,9	4	3,4	1,8	3,7	0,9	2,3	1,6	Mesomorph-Endomorph	(Orellana Lepe et al., 2018)
Philippines national university *	19,5	1,8	38	5,1	1,0	1,8	1,1	2,2	1,3	Balanced Endomorph	(do Kim et al., 2018)
Philippines national university **				4,6	0,9	2,2	1,2	2,5	1,0	Balanced Endomorph	
University Poland	21,2	1,8	30	3,1	0,9	3,9	1,0	2,7	1,0	Balanced Mesomorph	(Burdukiewicz et al., 2016)
Spain national team <49 kg	21,5	3,1	26	2,5	0,6	2,6	1,1	3,5	0,8	Balanced Ectomorph	(Pons et al., 2015)
Spain national team <57 kg	21,2	3,1	29	3,0	0,8	3,0	0,9	3,2	0,9	Central	
Spain national team <67 kg	21,7	4,3	28	3,2	0,8	3,4	0,7	2,7	0,8	Central	
Spain national team > 67 kg	20,6	3,4	10	3,6	1,1	3,8	1,3	2,2	1,2	Mesomorph-Endomorph	
Regional competitive Brazil	20	4,7	5	3,9	0,8	3,9	1,6	1,8	1,1	Mesomorph-Endomorph	(Campos et al., 2012)

n: Sample; SD: Standard Deviation; EN: Endomorphy; ME: Mesomorphy; EC: Ectomorphy; * Winner, ** Non-winner.

When analyzing the results for the somatotype components found in taekwondo women, the results, as in men, show great variability. The lowest levels of the endomorphic component were found in the Turkish national team athletes of the divisions <49 kg, <57 kg and <67 kg respectively, in contrast, in the Philippine university athletes, the highest levels of endomorphy are evidenced. On the other hand, when analyzing the results of the mesomorphic component, it shows a trend towards slightly higher levels, except for the one found in Filipino university athletes, who yielded the only result lower than 2.0 in this component.

The highest level found for mesomorphy was that of female athletes of the Turkish national team, of the division > 67 kg. Finally, when analyzing the results of the ectomorphic component, we can see that it presents more varied results. The Turkish selection athletes from the <49 kg and <57 kg divisions present the highest levels respectively. The lowest level of ectomorphy was presented by Brazilian athletes of regional competitive level.

4. Discussion

When analyzing the results of the 3 components of the

somatotype found in our search (Table 1), the mean for men would give us as a result 2.3 - 3.8 - 3 and for women 3.1 - 3.4 - 2, 7. If we classify these results as proposed by Carter, J (27), the mean somatotype for men is ecto-mesomorphic and for women it is the central somatotype. This analysis seems conclusive, if we refer only to trust the result of the mean, but when graphing the individual results on the somatochart, we can see the great dispersion of the results. In Figure 2B we can see the results for men, where there is clearly evidence of a dispersion of the data between the mesomorphic and ectomorphic components, also showing a slight tendency of the results towards the center of the graph.

In the case of women (Figure 2A), a dispersion of the results can also be seen in the graph towards the three components of the somatotype, although in this case the distribution of the data towards the center of the somatocard is more evident.

However, it is also important to analyze the result of the somatotype classification of each study. In Table 4, the number of athletes and the type of somatotype they present are presented, this allows us to have a clearer idea about which was the somatotypic classification that was found to a greater extent in the reviewed studies.

Table 4. *Classification of somatotypes found.*

		Central	Balanced Endomorph	Meso-Endomorph	Mesomorph-Endomorph	Endo-Mesomorph	Balanced Mesomorph
Men	Studies	2	0	1	3	3	6
	n	57	0	1	43	86	132
	%	8.7	0	0.2	6.6	13.2	20.2
Women	Studies	2	2	0	3	0	1
	n	57	38	0	19	0	30
	%	28.4	18.9	0	9.5	0	14.9

n: Sample; %: Percentage.

Table 4. Continued.

		Ecto-Mesomorph	Mesomorph-Ectomorph	Meso-Ectomorph	Balanced Ectomorph	Endo-Ectomorph	Endomorph-Ectomorph	Ecto-Endomorph
Men	Studies	6	5	4	2	0	0	0
	n	145	83	74	31	0	0	0
	%	22.2	12.7	11.3	4.8	0	0	0
Women	Studies	1	1	2	1	0	0	0
	n	5	12	14	26	0	0	0
	%	2.5	6	7	12.9	0	0	0

n: Sample; %: Percentage.

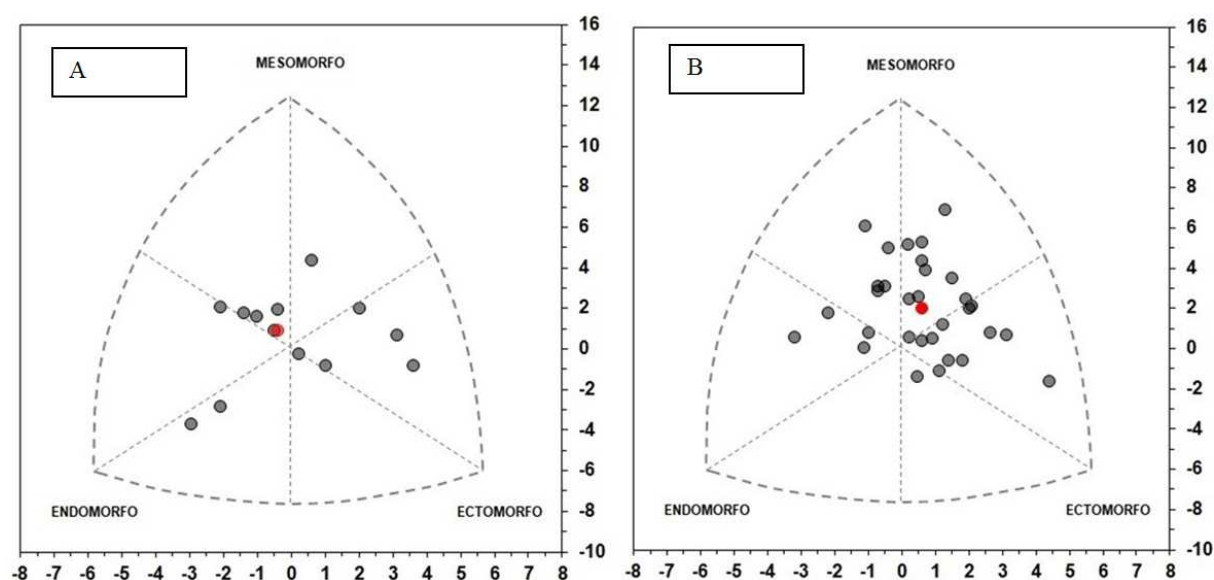


Figure 2. Somatochart athletes. A: Somatotype women; B: Somatotype men; Red dot: average somatotype.

In the case of men (Table 4), 9 different somatotype classifications were found, of the 13 proposals given by Carter, J [27]. On the other hand, the balanced mesomorphic and ecto-mesomorphic somatotypes were found in a total of 277 athletes representing 44.3% of the total sample. For the case of the female category (Table 4), 8 different somatotype classifications were found, of the 13 proposed by Carter, J [27]. The central somatotypic classification was the most frequent, observed in 57 athletes, representing 28.4% of the total sample.

If we take into account that mesomorphy is related to the predominance of musculoskeletal tissue and ectomorphy with relative body linearity, the average results found in men suggest that taekwondo players in general have good muscular development, relative thinness and low levels of fat, by presenting lower indices of endomorphy. This coincides with what was found by Bridge et al [13] in their review of the physical and physiological profiles of taekwondo athletes. Likewise, we can relate it to the body fat percentages that were also analyzed in this review, finding percentages of 7-14% in male athletes, which corroborates the lower results in the endomorphic component.

Regarding the results of the female group, Bridge et al [13] found mixed results in their review. On the one hand, in a group of international competitors they showed higher levels of the mesomorphy and ectomorphy components, but it was also found that a group of senior, youth and recreational

international athletes showed a central classification, which agrees with what was found in the present work. In any case, when comparing women with men, the female group showed a trend towards higher levels of endomorphy.

This may be due to the fact that women in general have higher levels of body fat than men, due to the accumulations that occur in the breasts and hips. We can verify this when reviewing the body fat percentages found in some studies such as that of Bridge et al [13] which found ranges of 12-19% in their review; the work of Pons et al [28] who determined fat percentages of 13.4% in Spanish national team fencers; In this same sense, Burdukiewicz et al [29], established in Polish university athletes of judo, jiu-jitsu, karate, taekwondo and fencing, fat percentages between 11.59% and 12.61% and finally Campos et al [30] found in Brazilian regional competitive taekwondo players an average fat percentage of 19.1%.

5. Conclusions

The study of body composition and somatotype is just one of the factors to take into account when carrying out the analysis of an athlete or a group of athletes. As we could see, for taekwondo athletes varied results were found, depending on the competitive level, the country, the weight category, but there was a certain trend towards outstanding values of the mesomorphic and ectomorphic component in men. Likewise,

in women, although fewer works were found to analyze, there was a trend towards a central somatotypic classification.

For a better understanding, these results should be analyzed taking into account other factors such as body fat levels, muscle mass percentages, measurements of the lower and upper extremities, as well as physical condition tests to measure their relationship with body composition. However, these studies must have the premise of classifying the athletes in relation to their competition weight, in order to have a segmentation, since as it could be seen, the weight division has a lot to do with the result of the analyzed factors.

It is essential that this type of studies continue, including in the analysis other types of variables, such as sports age, sports experience and educational level.

Author Contributions

BEPP and MRMR carried out the cleaning, tabulation and statistical analysis of the data. They also wrote the first draft of the manuscript. MRMR and CCPS performed the study design and data systematization. All authors reviewed and approved the final version of the manuscript sent to the editor.

Conflict of Interests

The authors declare that they have no conflict of interest.

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