

## Taekwondo, height and biomechanical advantage: a pilot project

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### Abstract

**OBJECTIVE:** Taekwondo, an ancient Korean martial art based mainly on the use of football techniques, became an official Olympic discipline in the 2000 Sydney edition. Its rapid spread in the immediate post-war period is mainly due to the continuous changes in the rules of the competition of combat (kyorugi), characterized by two main goals from its origins: the safeguard of the competitors' safety on the one hand, and the search for the increasingly objective formula for assigning scores on the other. Recently, we have witnessed the introduction of protection kits equipped with electronic sensors, which almost completely exclude the interpretation of the score and human error. Moreover, it is clear that these variations and changes in the rules have substantially changed the entire performance model, and consequently the morphology of the typical combat athlete. **METHODS:** The research was carried out by collecting and analyzing the heights of the athletes who took part in the Olympics, from 2000 Sydney Olympics until 2016 Rio de Janeiro Olympics. All 142 athletes who made it to the Olympic podium (gold, silver and bronze medals), all aged between 18 and 35 years (senior categories), divided into 71 male and 71 female athletes, and 8 weight categories ( -58 kg, -67 kg, -80 kg, +80 kg for male athletes and -49 kg, -57 kg, -67 kg and +67 kg for female athletes) were taken into consideration. The working assumption was to verify that the average height of the decorated athletes increased, edition after edition, favoring the biomechanical advantage driven by longer lower limbs (longer reach). **RESULTS:** The trends obtained from the comparison of average heights, both in the male and female field, confirm with a good approximation that the average heights of the athletes have been increasing Olympics after Olympics, starting from 2008 Beijing edition. **CONCLUSIONS:** As far as the conclusions are concerned, the initial hypothesis was clearly confirmed; the average height increased considerably, bringing a significant advantage in terms of biomechanical extension/reach for the lower limbs.

**Keywords:** taekwondo, height, reach, Olympics.

### Introduction

Taekwondo, literally *the art of flying kicks and punches*, [Bos, Favero, Giannerini, 1994; Fumarola, 2003; Jung, 2014; Ikpil, Namjungs, 2007; Choi, 1965; Sang, 2004] is a Korean martial art based mainly on the use of football techniques, and its most popular style, the WTF taekwondo [Bos, Favero, Giannerini, 1994; Fumarola, 2003; Jung, 2014; Ikpil, Namjungs, 2007; Choi, 1965; Sang, 2004] is also an Olympic discipline; at first it was demonstrative (1988 Seoul Olympics and 1992 Barcelona Olympics), then became fully integrated into the Olympic circuit from 2000 Sydney edition. Taekwondo originated from the union of the external styles of North China and the *taekkyon*, an ancient Korean martial art, literally meaning "fighting with the legs" [Bos, Favero, Giannerini, 1994; Fumarola, 2003; Jung, 2014; Ikpil, Namjungs, 2007; Choi, 1965; Sang, 2004,]. Only after the end of World War II it was possible to merge the combat techniques and the native styles into a single product, called taekwondo [Bos, Favero, Giannerini, 1994; Fumarola, 2003; Jung, 2014; Ikpil, Namjungs, 2007; Choi, 1965; Sang, 2004]. In Korea it soon became a national sport, and was included in the Korean national games since the beginning of the '60s; at the same time, it started to spread in the rest of the world thanks to the birth of the various world federations, distinguishing itself from other disciplines for its dynamism and spectacular power, and for the effectiveness of its leg techniques. The regulations of taekwondo's "kyorugi" (combat) discipline have undergone many variations and changes since May 28, 1973, which is the year of their first draft. From the very first moment, these changes have increased the spectacular power and the executive speed of the techniques, while preserving in any case the safety of the competitors. We have witnessed the introduction of body protectors, helmets and protections for the lower and upper limbs, up to the use of information technology for scoring. Currently it is possible to witness the maximum impartiality of the scoring, with totally electronic protection kits that completely exclude human error. It is clear that these advances in the rules have substantially modified, generation after generation, the interpretation and implementation of combat both from a technical-tactical and physical-conditional point of view. These changes have increasingly selected the morphology of the athletes suitable for the new performance models, identifying the reach of the lower limbs [Stecchi, 2004] as a very significant competitive advantage. The measurement of the athletes' height, directly

connected to the reach of the lower limbs and included in the set of Anthropometric Measurements together with other parameters in the literature, can therefore be the first and evident index of a change in the evolution phase.

**Working assumption**

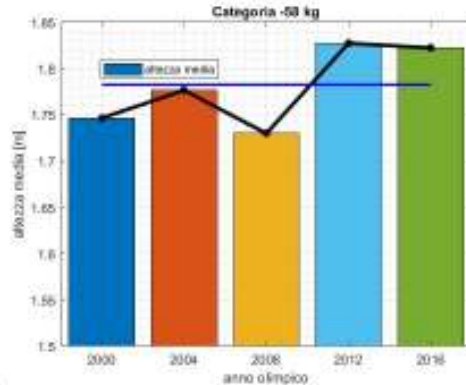
The research was carried out by collecting and analyzing [Erto, 2008] the height, current weight and age of the athletes who took part in the Olympics, from 2000 Sydney Olympics until 2016 Rio de Janeiro Olympics. All 142 athletes who made it to the Olympic podium (gold, silver and bronze medals) were taken into consideration. The first, second and third place winners in each weight category were involved in the taekwondo discipline. Therefore, the sample consisted of 142 athletes, all aged between 18 and 35 years (senior category), and divided into 71 males and 71 females.

The working assumption taken into consideration was to verify that the average height of the decorated athletes in the five editions of the games, where taekwondo was included in a stable and regular way in the Olympic context, was increasing edition after edition, favoring the biomechanical advantage driven by longer lower limbs, i.e. by a longer reach [Stecchi, 2004]. Comparing the 142 medalists for the male (-58,-67, -80, +80kg) and female (-49, -57, -67, +67kg) categories, we tried to predict the average increase in each weight category first, and for gender differences then.

**Results Analysis - Male Category**

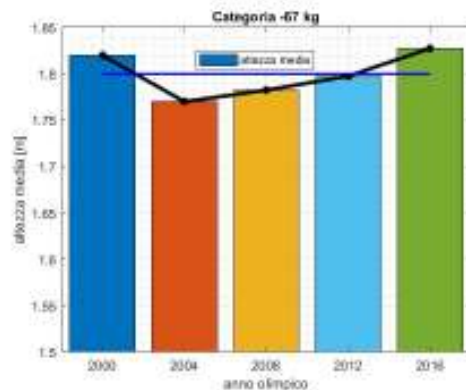
**-58KG**

In the first 2000 Sydney Olympics edition, for this weight category, the average height of the medalists was 1.75 m; in 2004 Athens Olympics was 1.78 m and decreased to 1.73 m in 2008 Beijing Olympics. It then increased to 1.82 m in 2012 London Olympics and settled on 1.82 m in 2016 Rio de Janeiro Olympics. The average height for this category in all the Olympic events is 1.78 m.



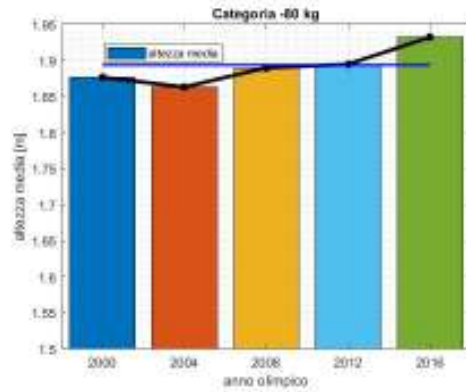
**-67KG**

In the first 2000 Sydney Olympics edition, for this weight category, the average height of the medalists was 1.82 m, in 2004 Athens Olympics was 1.77, and slightly increased to 1.78 m in 2008 Beijing Olympics. It reached 1.80 m in 2012 London Olympics and settled on 1.83 m in 2016 Rio de Janeiro Olympics. The average height for this category in all the Olympic events is 1.80 m.



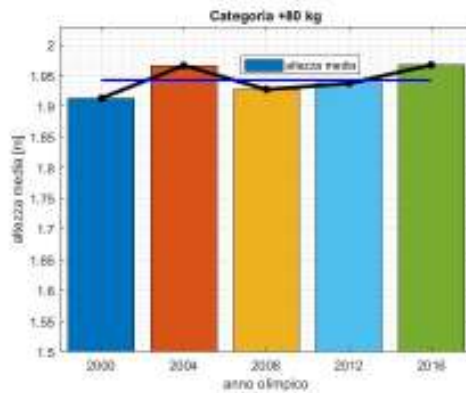
**-80KG**

In the first 2000 Sydney Olympics edition, for this weight category, the average height of the medalists was 1.88 m, which decreased to 1.86 m in 2004 Athens Olympics and increased to 1.89 m in 2008 Beijing Olympics. It settled to 1.89 m in 2012 London Olympics and increased to 1.93 m in 2016 Rio de Janeiro Olympics. The average height for this category in all the Olympic events is 1.89 m.



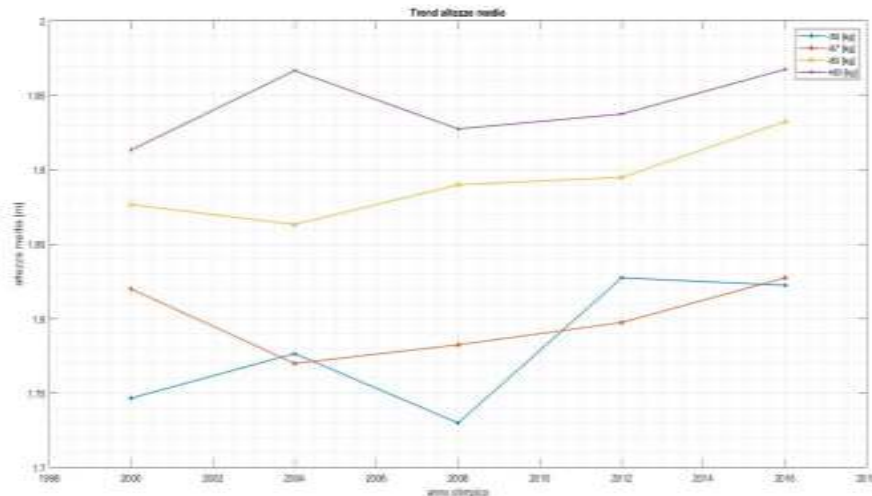
+80KG

In the first 2000 Sydney Olympics edition, for this weight category, the average height of the medalists was 1.91 m, which increased to 1.97 m in 2004 Athens Olympics and decreased to 1.93 m in 2008 Beijing Olympics. It slightly increased to 1.94 m in 2012 London Olympics and settled to 1.97 m in 2016 Rio de Janeiro Olympics. The average height for this category in all the Olympic events is 1.94 m.



### Male category trends

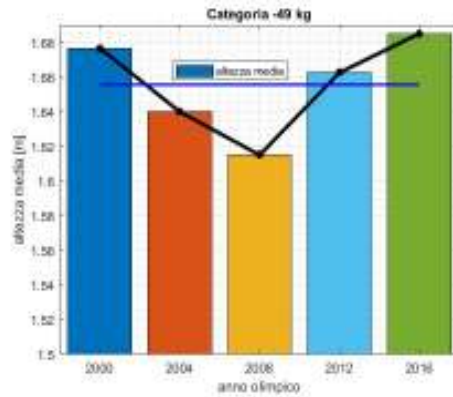
The first trend to take into account for the male category is clearly that the average height of the athletes after Beijing 2008, with a good approximation, proves higher than in previous editions. However, this is not the case for the -67kg men's category, in which a 1.90m athlete competed and won in the Sydney 2000 edition, raising the average height of the participants considerably. It should be noted that this athlete then competed and won in different weight categories. Furthermore, in the -58kg, there is a unicum marked by a decrease in height of 1cm, reported between London and Rio de Janeiro editions; despite this, such decrease cannot be considered significant in terms of stretch/reach. In the -58kg category, from Beijing to London and Rio de Janeiro, there is an increased average height of the athletes by 5 cm. In the other categories, the increase in the average height of the medalists is 4 cm.



**Results Analysis - Female Category**

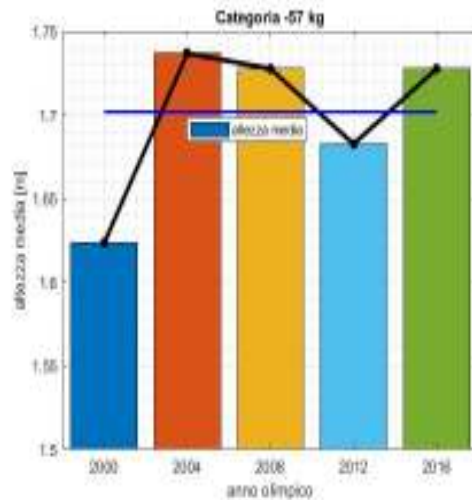
**-49KG**

In the first edition of the 2000 Sydney Olympics, for this weight category, the average height of the medalists was about 1.68 m, which decreased to 1.64 m in 2004 Athens Olympics and to 1.62 in 2008 Beijing Olympics. It increased to 1.66 m in 2012 London Olympics and settled to 1.68 m in 2016 Rio de Janeiro Olympics. The average height for this category in all the Olympic events is 1.66 m.



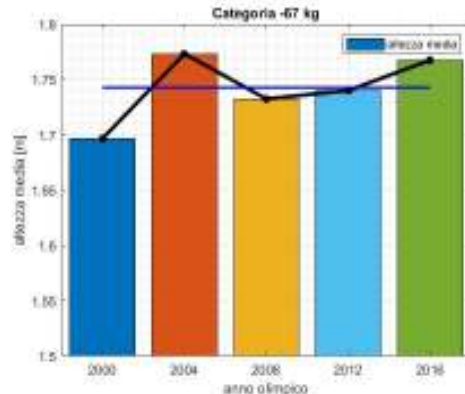
**-57KG**

In the first 2000 Sydney Olympics edition, for this weight category, the average height of the medalists was about 1.62 m, which considerably increased to 1.74 m in 2004 Athens Olympics, settled to 1.73 m in 2008 Beijing Olympics, decreased to 1.69 m in 2012 London Olympics and settled back to 1.73 m in 2016 Rio de Janeiro Olympics. The average height for this category in all the Olympic events is 1.70 m



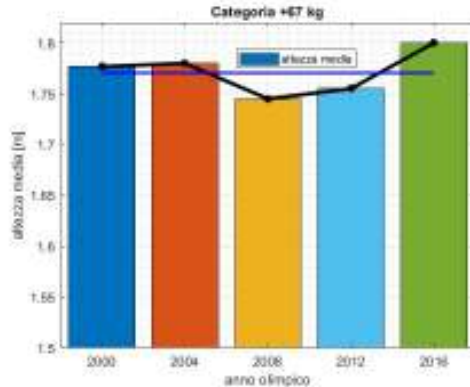
**-67KG**

In the first 2000 Sydney Olympics edition, for this weight category, the average height of the medalists was about 1.697 m, which increased to 1.77 in 2004 Athens Olympics, decreased to 1.73 m in 2008 Beijing Olympics, settled to 1.74 m in 2012 London Olympics and slightly increased to 1.76 m in 2016 Rio de Janeiro Olympics. The average height for this category in all the Olympic events is 1.74 m.



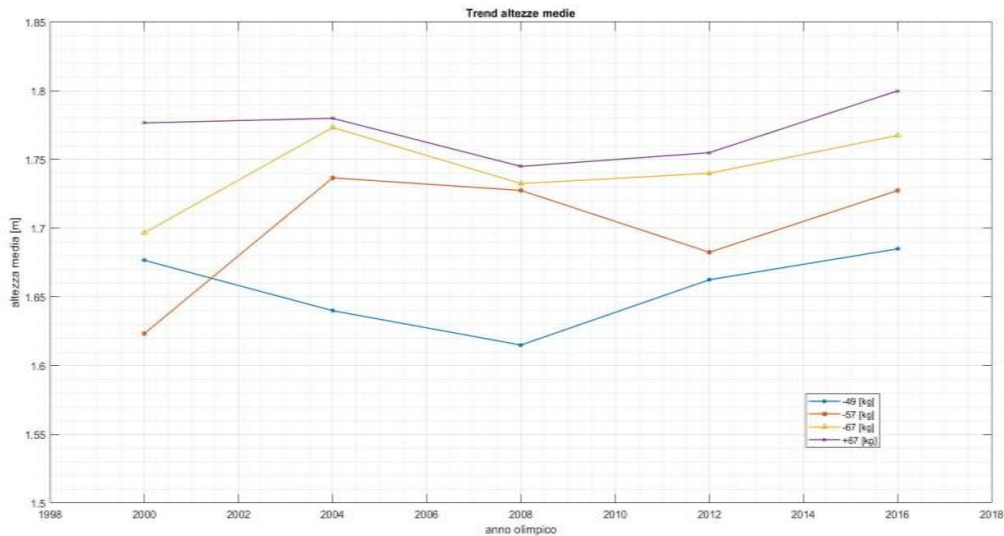
+67KG

In the first 2000 Sydney Olympics edition, for this weight category, the average height of the medalists was about 1.77 m, which increased to 1.78 m in 2004 Athens Olympics, decreased to 1.74 m in 2008 Beijing Olympics, settled to 1.75 m in 2012 London Olympics and increased to 1.80 m in 2016 Rio de Janeiro Olympics. The average height for this category in all the Olympic events is 1.77 m.



### Female category trends

For the female categories too, the 2008 Beijing edition is the watershed for the increase in the average height of the medalists. The trend was observed for the last three Olympic editions, starting from 2008 Beijing Olympics. However, there was a decrease in the average height between Beijing and London editions in the -57kg category. Actually, in this category, the average height proved to be extremely variable since the very first edition of the games; +12cm of average height gained between 2000 Sydney and 2016 Rio De Janeiro for female medalists. In this case, we cannot say that the post-Beijing medalists are averagely taller than those competing in the previous Olympic Games. A continuity line compared to the male categories, except for the -57kg one, is represented by an increase of +6cm in the -49kg category, +4cm in the -67 category, and +5.5cm in the +67 category between 2008 Beijing and 2016 Rio De Janeiro editions.



### Conclusions

Regarding the conclusions, once analyzed the results, it was evident the confirmation of the first hypothesis outlined; the average height of the medalists increased considerably and gradually not from the very first edition of the games, but since 2008 Beijing Olympics. Starting from this edition, the trend increased in seven out of eight categories considered, with the only exception represented by the -57kg female category, which saw a significant decrease in the average height between 2008 Beijing and 2012 London editions. It should be noted that there is also an increase between 2012 London and 2016 Rio De Janeiro editions.

As mentioned in the starting hypothesis, this increase in height brought a significant biomechanical advantage for medalists in terms of reach. Higher height means probably longer lower limbs, and in a sport with a prevalence of techniques performed with the lower limbs (soccer techniques), what previously mentioned becomes evident. Furthermore, another reason can be linked to the introduction of the scoring and electronic

protection system; moreover, the continuous changes and updates in the rules of the competition made by the World Taekwondo Federation were implemented mostly just after the 2008 Beijing Olympics. We are therefore witnessing a radical transformation of the functional combat model [Fox, 1979; Carrio, 2008; Weineck, 2003; 2009; Winter et al, 2010] in a clear and substantial way, favoring more and more the biomechanical advantage towards point fighting.

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