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**Original Article**

# Influence of block time in the final 50 and 100 meter swimming events classification.

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**Abstract**

In high level championships small details are able to define the swimming medalists. Overall 0.01 s represents just a short piece of swimming final time, but between elite swimmers just 1.12% of the final time performance in 50 meters freestyle are improved annually. In this perspective greater block time differences over swimming final time differences could change the importance of block time to the swimmers classification. Thus the aim was to investigate the influence of block time in the final sprint events (50 and 100m) classification, including seven FINA World Championships (2003-2015). Thereunto, were calculated the frequency of possible Classification Changes (CC), based on differences between block times (BT) and final times (FT) in each swimming event. Public data was collected at the Omega Timing website. Totally, 112 events and 894 individual results (447 men and 447 women) were analyzed. The Chi-Square test was used to verify the Classification Changes occurrence between strokes (freestyle, backstroke, breaststroke and butterfly), event distances (50 and 100m), sex (male and female), block versions (traditional block used by FINA until 2007 - OSB9; and new block used by FINA from 2009 - OSB11), and years of championship (2003, 2005, 2007, 2009, 2011, 2013 and 2015). Between strokes and distances, the Classification Changes effect was shown more frequent in backstroke and 50m (4.97% CC and 4.24% CC; respectively). In addition, although the new block version has been shown to reduce the block times, it did not affect notably the Classification Changes. However, overall differences in block times were greater than differences in final time events (3.44% CC). These findings emphasize the importance of BT and recommend the block start technical training to achieve better swimming classifications.
**Keywords**: Block Start; Classification Changes; Start Phase; Sprint Events.

## Introduction

In high level championships small details define the swimming medalists. In the Beijing Olympic Games (2008), the 100m men's Butterfly Olympian champion won by a difference of just 0.01 seconds (50.58s x 50.59s). As known, to achieve the best performance in targeted competitions it requires a complex model of interactions (e.g. power, technique, and strategy), especially in sprint events (Costa et al., 2010; Costill,et al., 1992; Tor, Pease, & Ball, 2015). Traditionally, it is possible to segment the swimming events into three or four distinct phases, depending on the pool (25 or 50m) or event lengths (50 or 100m): start; swimming; turn; and arrival (Costill et al., 1992; Vantorre et al., 2010). This segmentation helps to identify and promote fine adjustments throughout the training process, possibly improving the final performance in events (Costill et al., 1992). As featured in literature (K. De Jesus, K. De Jesus K, Fernandes, Vilas-Boas, & Sanders, 2014; Tor et al., 2015; Vantorre et al., 2014), biomechanical factors influence the start performance in swimming events, e.g. take off horizontal velocity, entry angles, and underwater trajectories. The start phase is the first and shortest in swimming events, and could be defined as the point between the start signal and the very beginning of the first stroke cycle breaking the water surface (K. De Jesus et al. 2014; Vantorre et al., 2010). In addition, the start phase is traditionally subdivided into five other sub phases: block; flight; entry; glide; and leg kicking (Vantorre et al., 2010). According to our best knowledge, no other start sub phase has received more scientific attention than the block phase, including several perspectives: biomechanics (Alptekin, 2014; Galbraith, et al., 2008; Tor et al., 2015), training methods (Bishop et al., 2009; Cuenca-Fernández et al., 2015; West et al., 2011), and block geometry (Honda et al., 2012; Kibele et al., 2015; Takeda et al., 2012).

Changes that occurred in FINA rules (SW 7; FR 2.7) at the FINA World Championships (Rome, 2009) (K. De Jesus et al., 2013; Honda et al., 2012; Kibele et al., 2015), resulted in a large amount of studies that have investigated the impact of the new block (OSB11) configuration on swimming performance (Garcia-Hermoso et al., 2013; Slawson et al., 2011; Takeda et al., 2012). Those changes were, for example, the inclusion of an "adjustable, slanted footrest" to ventral strokes (butterfly, breaststroke and freestyle) (Vantorre et al., 2014) and three different start handgrips (i.e., two horizontal and one vertical) for dorsal stroke (backstroke) (K. De Jesus et al., 2014). One parameter used to investigate the impact of block configuration changes is the "reaction time"


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(RT), the official term used by FINA (*Fédération Internationale de Natation*), or the scientific term "block time" (BT), is the combination of the time interval between the start signal and the first movement and the time interval between the first movement and the last contact of the feet with the block or wall (Sanders, 2002; Vantorre et al., 2010). A few studies showed correlations of BT (r ~0.6) with the total start time until the 15 m mark (Cossor & Mason, 2001; Vantorre et al., 2010). In addition, other studies related the BT with the final time (FT) events (Garcia-Hermoso et al., 2013; Mason and Cossor, 2000; Tanner, 2011). In this sense, the results of Mason and Cossor (2000) and Garcia-Hermoso et al. (2013) showed that BT is related to the FT in the traditional block version, (50m: $r = 0.84$, $p < 0.01$; $r = 0.278$, $p < 0.001$; 100m: $r = 0.50$, $p < 0.05$; $r = 0.302$, $p < 0.001$, respectively). Moreover, Garcia-Hermoso et al. (2013) analyzed swimmers based on their classification; medalists (1st to 3rd), finalists (4th to 8th), e semi-finalists (9th to 16th) of 50 and 100m freestyle events. They found that medalists BTs were faster when semi-finalists in 50 and 100m events (p= 0.006 and 0.017, respectively) for the traditional block (OSB9). In addition, comparing sexes and block versions, they found meaningful differences between men and woman for 50 and 100m events ($p<0.001$), showing also faster men's BTs to both block versions ($p<0.001$). As a result, Garcia-Hermoso et al. (2013) showed mainly that the traditional block was capable to influence the BT and the final performance (between sexes, events and classification groups, $p<0.001$). Nonetheless, after analyzing 225 start events in Atlanta 1996 Olympic Games, Tanner (2011) pointed a low contribution of block phase in the FT performance, considering the traditional block for male and female events (50m, r=0.35 and 0.22; 100m, r= 0.29 and -0.19; $p<0.05$ respectively).

However, after analyzing 26 international competitions between 2000 and 2012, Garcia-Hermoso et al. (2013) indicate that the BT average of sprint swimmers (50 and 100m freestyle) of both sexes is approximately, $0.76 \pm 0.06$s and $0.77 \pm 0.06$s, and the FTs, $23.93 \pm 0.36$s and $52.32 \pm 0.62$s, respectively. In this sense, the BT represents just 3.17% of the final 50m events and 1.47% of the final 100m events. As known, in high level championships small details are able to define the swimming medalists. On the one hand, 0.01 s represents just 0.04% and 0.01% of 50 and 100m final time events, respectively. On the other hand, over the times, the records improvement has become gradually rare in swimming championships (Costa et al., 2010). Relying on the first 150 swimmers placed in world FINAs top ranking between the Olympic cycles (2004 to 2008), Costa et al. (2010) showed an approximate annual improvement of just 1.12% in the FT of 50m freestyle, and 3 to 4% for 100m at the end of the Olympic cycle previously cited. Thus, the role of centesimal differences between swimmers BTs would become larger than thought before. Moreover, taking into account the greater BT differences between two swimmers than their FTs, the importance of BTs becomes more relevant to the classification. However, there is a short amount of studies which investigated this thematic (Cossor and Mason, 2001; Garcia-Hermoso et al., 2013; Tanner, 2011). According to our best knowledge, none of them has investigated this thematic in function of the differences between BTs and FTs in swimming. Furthermore, if a pattern is established regarding the classification changes due to the BT and FT differences, we would be able to have a more specific perspective on this issue, which could increase the importance attributed to swimming BT for swimmers, coaches and researchers. For this reason, the main objective of this study was to investigate the influence of block time in the final sprint events (50 and 100m) classifications. Thereunto, this study calculated the frequency of Classification Changes (CC), based on the differences between the BTs and the FTs for each swimmer. It is hypothesized that centesimal differences in BTs are greater than differences in FTs. As a consequence, BT could influence the swimmers classification in a decisive matter.

## Material and Methods

### *Data Collection*

All the final times (FT) and block times (BT) were analyzed in each event distances (50 and 100m), including sexes (male and female), four swimming strokes (butterfly, backstroke, breaststroke and freestyle) of all eight finalists of seven FINA World Championship (2003, 2005, 2007, 2009, 2011, 2013 and 2015), all occurred in 50m length swimming pool. Overall, 894 individual results were analyzed (447 men and 447 women) in 112 events. Two swimmers were disqualified and not included in the present study (50m men's breaststroke in 2003, and 50m women's breaststroke in 2013). Public data was obtained on the Omega Timing website (www.omegatiming.com/). FINA (*Fédération Internationale de Natation*) uses the term "*reaction time (RT)*" in reference to the time defined as the time interval between the start signal and the instant the swimmer's feet left the block. This information (*RT)* is recorded with precision of 0.01s by the timing console of the championship in a real time system. The starting block platform contains a mechanical contact switch mounted between the top of the starting block and the base. The switch is closed when a swimmer is standing on the platform, and opens when the swimmer's feet leave the block following a start signal (Garcia-Hermoso et al., 2013; Tanner, 2011). For each event, the difference between the BTs of two swimmers were compared with the difference of their FTs. If the difference between the BTs were greater than between their FTs, it was identified a potential classification change. In that way, the number of Classification Changes (CC) indicate how many times one swimmer would have won against other if both had established the same BT. With this new parameter (%CC) it is possible to identify if swimmers got a better classifications due to a shorter BT or due to the remainder event time (FT).

*Statistical Analysis*

The Chi-Square test was used to verify the differences in the CC occurrence frequency between strokes (freestyle, backstroke, breaststroke and butterfly), event distances (50 and 100m), sex (male and female), block versions (traditional block used by FINA until 2007 - OSB9 and new block used by FINA from 2009 - OSB11), and years of championship (2003, 2005, 2007, 2009, 2011, 2013 and 2015). It was also calculated the confidence interval for all the comparisons. The normality of the BT data was verified by the Kolmogorov-Smirnov test and the equal variance by Levene test. The one-way ANOVA was used to compare the absolute values of BT between strokes and years, and the *post hoc* Student-Newman-Keuls was used to identify the differences. The t-test was used to compare the absolute values of BT between distances and sexes. For the comparisons between years, sexes and distances, the BT of ventral strokes: butterfly, breaststroke and freestyle were grouped as Outside pool Starts (OS), and the BT of dorsal stroke: backstroke was considered Inside pool Start (IS). Then the analyses of OS and IS were performed separately. For all comparisons, the Hedges effect size (g) was calculated with a confidence interval of 95% (95%CI). The significance level was set at $p < 0.05$.

**Results**

*Occurrence of Possible Classification Changes Due to Block Time*

The CC was identified 108 times between 3.136 possible chances (3.44%). The CC of each factor is presented in Fig. 1. There is a notable difference in the occurrence frequency of CC between the swimming strokes ($\chi^2_{(3)}$=7.888; p=0.048); the backstroke was more susceptible to changes than the others swimming strokes (Fig. 1a). The difference in the occurrence frequency of CC between event distances was also influential ($\chi^2_{(1)}$=5,749; p=0.016), and the 50m was more susceptible to changes than the 100m, as shown in Fig. 1b. There is no meaningful variation in the occurrence frequency of CC between sexes ($\chi^2_{(1)}$=2,454; p=0.117; Fig. 1c); between the block versions ($\chi^2_{(1)}$=0.061; p=0.804; Fig. 1d); and between years ($\chi^2_{(6)}$=5,352; p=0.499; Fig. 1e).

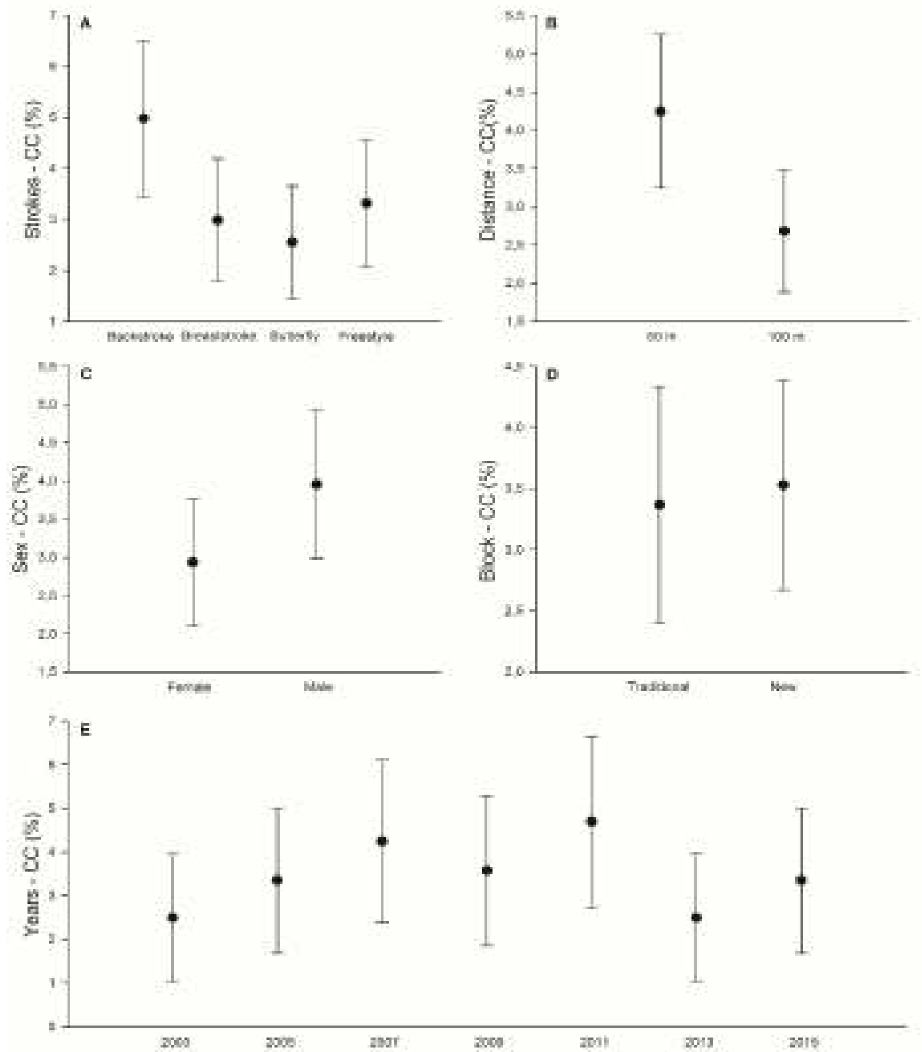


Figure 1: Classification Changes (CC) in %, and confidence intervals (95%CI) for each swimming stroke (A; backstroke, breaststroke, butterfly or freestyle), event distance (B; 50 or 100m), sex (C; male or female), block

version (D; traditional until 2007 or new block from 2009 to 2015) and year (E; 2003, 2005, 2007, 2009, 2011, 2013 or 2015).

**Block Time in function of the factors**

The Fig. 2a presents the average and standard deviation values of BT between swimming strokes. The backstroke BT (0.647 ± 0.071 s) was notably lower than all other swimming strokes (p <0.001): breaststroke (g = -0.84, 95%CI -1.03 to - 0.65); butterfly (g = -1.01, 95%CI -1.20 to -0.81); and freestyle (g = -1.05, 95%CI = -1.25 to -0.85). When comparing the BT between sexes (Fig. 2b), in the OS men were faster than woman (g = 0.47; 95%CI 0.31 to 0.62; p < 0.001). For the IS there was no influential difference between sexes (g = 0.06; 95%CI -0.21 to 0.32; p = 0.677). Comparing the event distances (Fig. 2c), BTs were shorter in 50 than 100m for both, OS (g= -0.26; 95%CI = -0.42 a -0.11; p<0.001) and IS (g= -0.32; 95%CI = -0.59 a -0.06; p=0.015). Comparing BT over the years (Fig. 2d), with regards to the IS, the years from 2003 to 2007 had a BT greater than the years 2009 to 2015. On the other hand, OS from 2003 to 2009 showed BT greater than the years 2011 to 2015.

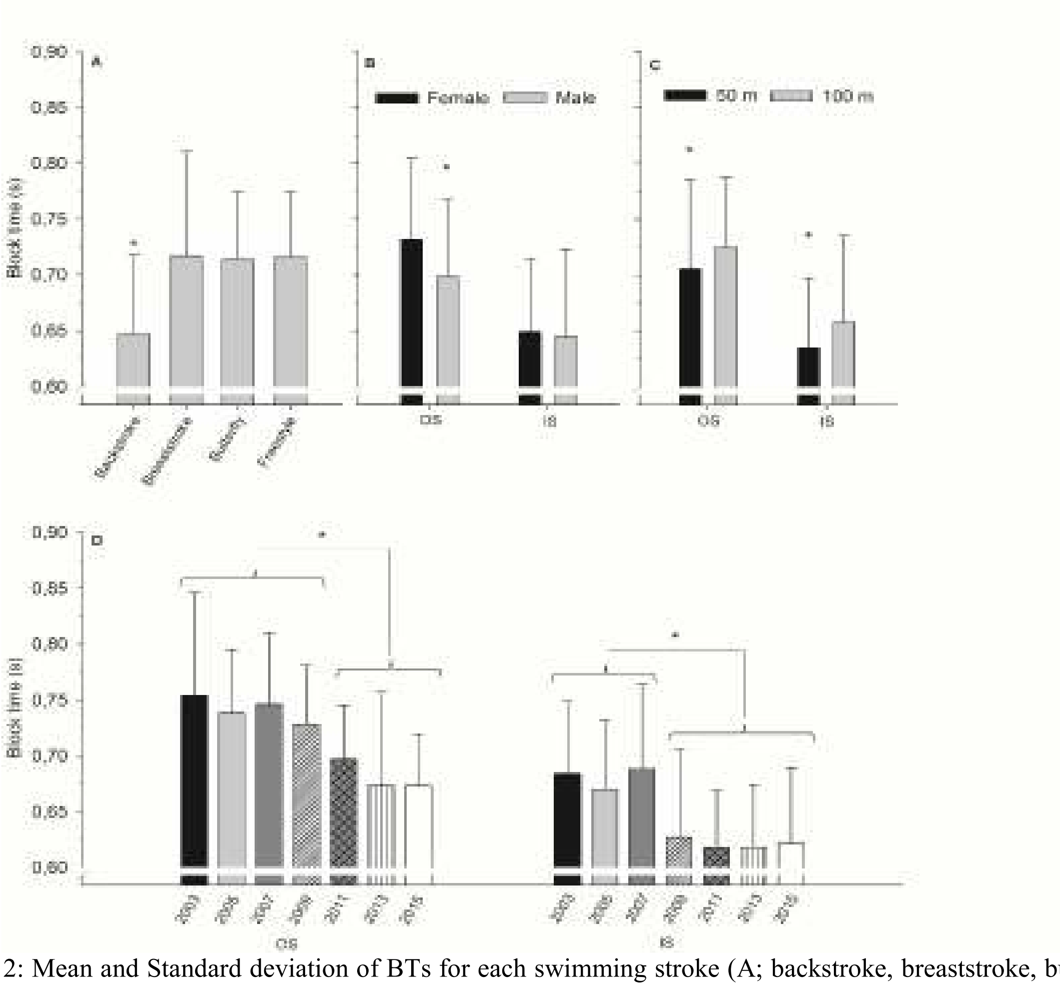


Figure 2: Mean and Standard deviation of BTs for each swimming stroke (A; backstroke, breaststroke, butterfly or freestyle), distance (B; 50m or 100m; Inside pool Start (IS) or Outside the pool (OS)), sex (C; female or male; Inside pool Start (IS) or Outside the pool (OS)), and year (D; 2003, 2005, 2007, 2009, 2011, 2013 or 2015).
* Significant differences (p <0.05).

**Discussion**

This study analyzed the importance of swimming BT to the final classifications in sprint events (50 and 100m), including seven FINA World Championships (2003-2015). The main result showed that BT could have changed 3.44% of the classifications in the final events. Furthermore, it was expected that less than 5% of these changes happened due to random chance, as demonstrated by 95% CI in Fig. 1, thus it seems that 3.44% of the classification changes are mostly represented by the real effect of BT and no other influence factor. Even so, just one study agrees on directly correlations between BT and FT performance (Garcia-Hermoso et al., 2013). On the other hand, another study proposes a devaluation of BT in sprint events, where just 12% of the FT performance is explained by BT (Tanner, 2011). However, this present study shows through a new perspective of data analysis a great valuation of BT in sprint events, not just emphasizing the importance of tenths and hundredths in sprint swimming, but also shows that BT could define the swimmer classifications on FINA World Championships.

Comparing strokes, the backstroke has presented a smaller BT in relation to others. In addition, backstroke classifications also have greater possibility to be influenced by the BT (CC=4.97%) than the OS strokes, emphasizing BT specific importance. In literature reviews, both starts, IS (K. De Jesus et al., 2014) and OS (Vantorre et al., 2014), were analyzed in order to achieve a better BT. Additionally, they suggest that it is necessary to have the shortest time as possible in contact with the block or wall, in order to minimize the block time (K. De Jesus et al., 2014; Vantorre et al., 2014). However, there is a need to remain at the block or wall long enough to generate the greatest horizontal force as possible (K. De Jesus et al., 2014; Vantorre et al., 2014). In pursuance of achieving the best BT performance, it would be reasonable to assume that swimmers need to find an optimal balance between a faster movement and greater horizontal impulse. Between events, the BT in 50m was shorter than in 100m in both start types, IS and OS. As a rule, it seems the importance of BT to final classification definitions decreases as the event distance increases (Mason and Cossor, 2000). Perhaps greater attention were given to the block starts in the swimming training complexity, which was prioritized in 50m training in relation to the 100m events. The same relationship between the distance events and the influence of BT in the result was also confirmed by higher CC found in the tests of 50m (4.25%). In this sense, the importance of technical training to achieve a faster block start appears to have great importance to 50m events, because it can define final classifications distribution in greater numbers (3.44%). Considering the comparison between sexes, the male BT was faster in the OS in relation to the female BT. Indeed this fact could be justified with the singular anatomical, anthropometric and conditional characteristics that makes up the differences between the sexes (Garcia-Hermoso et al., 2013; Thanopoulos et al., 2012). The meaningful differences of BT in the IS, probably occurred due to unfavorable mechanical position of force application before 2009 rule changes, due to the new handgrips and feet positions (K. De Jesus et al., 2011). There were no changes in the CC distribution between the sexes, which could be explained due to adaptive variability that emerges during the block start (Vantorre et al., 2014), despite of the known differences between the sexes (Garcia-Hermoso et al., 2013; Thanopoulos et al., 2012; Wild et al., 2014). The literature also points an absence of any differences of block start inter-subject (expert versus non-expert), inter-trial or intra-subject (through repetitions of the same movement), and also inter-preference (preferred versus non-preferred technique) (Vantorre et al., 2014).

Between block versions, the BT reduction in the new block can be related to variations in feet geometry, joint angles and gravity center position (Kibele et al., 2015; Slawson et al., 2012; Slawson et al., 2011). Furthermore, to justify these variations, Kibele et al. (2015) shows an average improvement of 0.06s up to 0.14s in the BT by kinematical adjustments in preferred swimmers positions in block start. The majority of the improvements at the new version OSB11 were associated with a change to the front weighted stance, a narrow foot displacement, and an elevated center of mass position (Kibele et al., 2015). Despite of this fact, it is clear that BT development after the new block inclusion, did not change the CC distribution over the years. Although the block configuration do influence the BT, the performance development seems to be similar for all swimmers and would not alter the swimmers classifications. For the time difference in IS, a plausible hypothesis could be explained by biomechanical factors (K. De Jesus et al., 2011); the joint of the knees and hip angles reduced, as well as the center of mass positioning, represent a faster application of force to prevent further drag in the water. In that case, the power relationship could be explained by the ratio between strength and speed, it could also be more emphatic in IS than in OS, because in IS a greater push would need to be generated to reduce the water drag (K. De Jesus et al., 2011; 2014; Nguyen et al., 2014). Over the years, it was found that BT in both start types (IS and OS) between the years of 2003 and 2007 (traditional block, OSB9) were faster than the years of 2011 and 2015 (new block, OSB11). In 2009 (the first FINA World Championship with the new block) there was a difference in the BT analysis between IS and OS. For IS, those differences were greater in relation to the years before and similar to the next championships. On the other hand, the OS showed opposite results. It is speculated that this divergence could be related to an easier IS strokes familiarization (K. De Jesus et al., 2011; 2014; 2013), due to the higher magnitude of the changes in new block for OS strokes (kick-plate and handgrips).

**Conclusion**

The main result shows that differences in BT were greater than FT events (3.44%), influencing the swimmers classification. Indeed CC was greater in backstroke and 50m events, where the BT was also lower. Although the new block reduces the BT in 2009, it did not produce changes in the number of CC. These findings emphasize the importance of BT and recommend the block start technical training to achieve better swimming classifications. However, these data only includes the information from the seven FINA World Championships (2003-2015), thus the authors encourage the study replication including also the Olympic Games and future international championships.

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