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Relationship between starting and finishing position in World Cup BMX racing

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Abstract

The BMX start is one of the most important aspects of BMX racing and has been deemed by coaches as one of the strongest determining factors of finish line placing. The present study analysed the correlation between elite BMX riders and their relative position at the start of a BMX race in relation to finish line placing. Data from 348 riders results in 175 elite races in the four 2012 Union Cycliste Internationale (UCI) world cup events were analysed. Time gates were placed in four positions around each BMX track and the data sets were analysed using Kendall's tau-b bivariante correlation. A strong correlation was established at the second time gate for both males (t=0.581, P<0.01) and females (t=0.571, P<0.01). The correlation between riders' final placing was greater in positions 1st to 3rd (t=0.586, P <0.01. 4th to 8th t=0.249, P <0.01) compared to riders placed 4th to 8th (t=0.519, P <0.01. 4th to 8th t=0.372, P <0.01.) for both male and female riders respectively. In conclusion, a strong correlation exists between riders position 8-10 s into a race. Therefore, focusing on a riders' ability to gain placings at the start of a race will have an effect on their finish line position.

Key words: Bicycle motocross, Union Cycliste Internationale, Cycling performance, Start gate, Time gate

1. Introduction

Bicycle motorcross (BMX) was first recognised by the Union Cycliste Internationale (UCI) as an official cycle racing discipline in 1983. However, BMX cycling was not formally acknowledged as an Olympic sport until 2008, when it was introduced at the Beijing Olympic Games (China). A standard BMX track includes a number of corners called berms, and a series of combination jumps, which are graded with various degrees of technical difficulty. The competition format for BMX racing involves a number of qualifying heats called Moto's in which the fastest four riders from each group qualify for the quarter finals, semi-finals and eventually the final. A typical Moto is contested by riders on a race track consisting of eight lanes, and in contrast to other cycling disciplines, such as, for example Mountain Bike Racing, the riders start position is allocated randomly and not determined by a seeding system (Macdermid & Morton, 2012). However, a rider's finishing position in the Moto determines the lane they will occupy in the quarter-finals and semi-finals (e.g. the rider finishing first in the Moto gets the preferred choice of lane for the next round). The start procedure for a BMX race commences with a series of verbal electronic commands, and the dropping of an electrical start gate (UCI rules and regulations). The technical phases associated with the BMX start are reported in detail elsewhere (i.e. Zabala, Sáchez-Muñoz, and Mateo, 2009) although a brief description is described below.

The start contains three distinct phases. Phase 1 begins with the rider waiting, with the front wheel resting against the start gate. In phase 2, the rider is standing with the feet in the toe clips of the pedals. During phase 3 the rider pays maximum attention to the fall of the start gate, and has the pedals positioned at an angle designed to generate the maximum power once pedaling commences (Zabala, Sáchez-Muñoz, and Mateo, 2009). The duration of BMX cycling races have been recorded between 30 s to 50 s (Cowell et al. 2012) and therefore the sport is considered predominantly as a sprint type event (Zabala et al. 2008). The importance of the start in sprint type events has been reported previously in a number of sports including: speed skating (Maw et al. 2006; Muehlbauer 2010; Muehlbauer & Schindler 2011) and 100m, 200m and 110m hurdles in athletics (Pilianidis et al. 2012).

Previous scientific research surrounding the start in BMX racing have examined the effects of external feedback as a protocol designed to improve performance and starting efficiency. For example, Zabala et al. (2009) demonstrated using an intra-group experimental design the positive effects of visual feedback as a means of improving rider performance at the gate start. Other related studies have investigated the optimal starting technique (e.g. Mateo & Zabala, 2007). Whilst Herman et al (2009) investigated the time to peak power in five male riders on the USA national BMX squad. Herman recorded peak power values occuring 1.6 s into a simulated race on the Beijing Olympic BMX track. However, the research surrounding the relevance and importance of the start in BMX racing, and its relationship with a riders finishing position is currently unknown, and is therefore worthy of further scientific investigation.

Despite the previously cited studies, BMX related research is still very much in its infancy. However, aforementioned studies have tended to focus on the technical aspects of BMX racing (Mateo et al. 2012), technique time motion analysis (Cowell et al. 2011), and the physiological characteristics of the BMX athlete (Rylands et al 2013; Bertucci & Hourde 2011).

Due to the relative shortage of start and finishing related research in BMX racing, comparisons with similar studies adhering to this methodology are somewhat problematic. However, the influence of the start and its relationship with the finishing position has been reported in other sprint race events, for example, short track ice speed skating (Muehlbauer & Schindler, 2011). Muehlbauer & Schindler (2011) for example, were able to demonstrate for both male and female skaters that a positive correlation existed between starting and finishing positions. The strength of the correlation decreased in relation to the actual race distance, with the strongest correlations associated with race distances of 500m and the weakest in the 1500 m races (Muehlbauer & Schindler, 2011). Similarly, data collected from World Cup cross-country elite mountain bike cyclists over a ten-year period also revealed an association between the start and finishing position (Macdermid and Morton, 2012). Specifically, Macdermind & Morton (2012) reported a positive correlation between starting and finishing position for those riders who gained a position at the front of the bunch during the start of a race. Macdermid and Morton (2012) concluded that the influence of the starting position was strongly significant, and should influence a coach's decisions regarding physiological and strategic approaches to training.

As mentioned previously BMX related research is still very much in its infancy. Previous research has tended to focus on the technical aspects of BMX racing (Mateo et al. 2012), technique time motion analysis (Cowell et al. 2011), and the physiological characteristics of the BMX athlete (Rylands et al 2013: Bertucci & Hourde 2011). There is currently an absence of BMX studies undertaken to assess the influence of the start and the eventual finishing position. Therefore it would be a valuable addition to the current sports science literature to examine this supposition. Specifically, therefore we hypothesized that the rider's finishing position is determined within the first few seconds of the race, and this relationship would occur in both male and female races.

2. Methods

2.1 BMX race data collection

In order to determine the influence of the start on the finishing position in BMX racing, riders' positions were analysed at four points around a BMX track during the 2012 Union Cycliste Internationale (UCI) World Cup series. Data were accessed from the official, publicly accessible UCI BMX results website (www.bmx-results.com). The research protocol and design received ethical approval from the University of Derby Ethics Committee.

Data from 175 World Cup BMX races (female n=52, male n= 123) and 348 riders (female n=108, male n= 240) from four different counties were subsequently recorded and analysed (Canada, Holland, Norway, and USA). Each individual race consisted of between 6 to 8 riders and their race position was recorded using an AMB Mylaps ChipX-Decoders and a transponder that was fitter to all riders' bikes. BMX race tracks have 8 lanes, but 6 may be used on the Moto's [qualifying rounds] if the number of competitors entered in the event is low. Each time gate was placed at specific time intervals around the four tracks; for example: Time gate 1: 1.0746 ± 0.8159 s. , Time gate 2: 8.2686 ± 1.03190 s., Time gate 3: 20.5418 ± 4.51059 s., Time gate 4: 29.7275 ± 3.66370 s., Finish line 32.1579 ± 3.12389 s. Each BMX track is unique in design (Louis et al. 2012) and consequently the time gates were placed at time intervals rather than distances. By placing the time gates at specific times, and not distances reduced the possibility of a time gate being situated at the midpoint of a jump or berm and thus eliminating the potential for recording inaccurate data. In addition the length of the track is sometimes shortened for female competitors.

2.2 Data analysis

The BMX riders' relative position to other riders in the race at all four time gates were recorded and coded 1 to 8 or 1 to 6 if there were fewer participants in the race. In line with similar final positioning studies, the riders who did not begin the race, or complete the course due to crashing, were excluded from the final analysis (i.e. Muehlbauer & Schindler, 2011). Exploratory analyses employed Shapiro-Wilk and Levene's tests to check for normality and homogeneity of variance. As the assumptions for normality were violated, and to determine whether an association existed between starting and finishing position, all data were examined using the non-parametric Kendall's tau-b test for rank correlation (Muehlbauer & Schindler, 2011). Using Cohen's (1988) interpretation of magnitude, a weak correlation was associated with a recorded value between 0.0 and 0.2, a moderate to strong correlation between 0.2 and 0.5, and a strong correlation at 0.5 and above. The data for both male and female riders were analysed in all four competitions using the Statistical Package for Social Sciences (SPSS) version 19.0 (SPSS Inc., Chicago, IL, USA). The level of statistical significance was set at $P < 0.05$.

3. Results

The combined timed results from all four competitions are illustrated in Table 1. The results show that all time gates were placed at comparatively similar positions irrespective of track design.

Table 1. The time taken for riders to travel from the start gate to each time gate during all four 2012 UCI world cup races.

Event	Time gate 1 (Time in sec)		Time gate 2 (Time in sec)		Time gate 3 (Time in sec)		Time gate 4 (Time in sec)		Finish line gate (Time in sec)	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Canada	0.9671	1.0547	7.3763	8.2354	16.6405	18.5287	25.2972	28.3512	32.7247	36.6535
mean±SD	0.4514	0.0471	0.2342	0.0728	0.9503	0.9952	1.2995	1.3324	1.7245	1.5463
Holland	1.1374	1.2440	9.6815	11.3623	27.0896	26.3674	33.8530	34.2699	41.3219	42.9978
mean±SD	0.0368	0.0835	0.4184	1.0679	1.1710	2.6129	1.3747	2.5973	1.6804	3.8903
Norway	1.0551	1.1623	7.5366	8.3761	17.6133	19.9427	28.0006	32.0417	34.0510	38.9348
mean±SD	0.0295	0.0396	0.2722	0.3080	0.9955	0.8943	1.3204	1.1961	1.5998	1.5979
USA[1]	1.2066	1.1635	11.0174	8.3849	21.0725	19.9650	31.7880	32.0733	39.8203	38.9835
mean±SD	0.0491	0.0396	1.0502	0.3119	2.6869	0.9049	1.9307	1.2052	2.5332	1.6085
Combined	1.0746	1.1833	8.2686	9.8963	20.5418	21.9534	29.7275	32.1579	36.6703	40.1595
For all events	0.8159	0.1043	1.0319	1.8125	4.5105	3.9134	3.6637	3.1238	4.0170	3.1724

Note[1]: During the USA series the female riders competed on a shortened track.

The female and male results are displayed in Table 2 and Table 3 respectively. The results show a strong positive correlation at the start of all races. The combined results demonstrate a correlation existed early in the race from start gate 2 in both male and female riders (Males =8.2686 ± 1.03190 s, females = 9.8963 ± 1.81258 s). The results also show a significant positive correlation between the male riders ($t = 0.581$, $P < 0.01$) and the females riders ($t = 0.571$, $P < 0.01$) at time gate 2.

Table 2. The correlation between start gate and finish line position for all female riders during 2012 UCI world cup events.

Event/ Gate	Time gate 1	Time gate 2	Time gate 3	Time gate 4
Canada				
Combined results	0.454*	0.504*	0.652*	0.829*
Position 1st to 3rd	0.430	0.602**	0.465	0.732*
Position 4th to 8th	0.179	0.255	0.422**	0.774*
Holland				
Combined results	0.374	0.536*	0.840*	0.927*
Position 1st to 3rd	0.164	0.518*	0.647*	0.859*
Position 4th to 8th	0.280*	0.315*	0.741*	0.882*
Norway				
Combined results	0.430*	0.503*	0.820*	0.956*
Position 1st to 3rd	0.086	0.482*	0.689*	0.911*
Position 4th to 8th	0.303*	0.243*	0.623*	0.900*
USA				
Combined results	0.411*	0.737*	0.921*	0.971*
Position 1st to 3rd	0.018	0.549*	0.898*	0.942*
Position 4th to 8th	0.418*	0.713*	0.801*	0.941*
All events				
Combined results	0.408*	0.571*	0.837*	0.939*
Position 1st to 3rd	0.126	0.519*	0.719*	0.887*
Position 4th to 8th	0.313*	0.372*	0.687*	0.893*

Note: The higher the size of Kendall's tau-b rank correlation coefficient, the stronger the correlation: 0.0 to 0.2-weak, 0.2 to 0.5-moderately strong, and < 0.5 strong. The asterisks indicate positive statistical significance (*significant at P= 0.01, **significant at P= 0.05)

The correlation between riders' final position are greater in positions 1st to 3rd compared to riders placed in position 4th to 8th at start gate 2. The only exception to this finding are the female riders who competed in the USA series (1st to 3rd t = 0.549, P < .001. 4th to 8th t = 0.713, P <.001.). However, a strong correlation still exists between time gate 3 and final positing. This could be attributed to the high number of female riders crashing prior to gate 2 in the race causing many riders to avoid obstacles on the track.

Table 3. The correlation between start gate and finish line position for all male riders during 2012 UCI world cup events

Event/ Gate	Time gate 1	Time gate 2	Time gate 3	Time gate 4
Canada				
Combined results	0.438*	0.716*	0.878*	0.931*
Position 1st to 3rd	0.416*	0.682*	0.901*	0.924*
Position 4th to 8th	0.181**	0.327*	0.658*	0.774*
Holland				
Combined results	0.243*	0.586*	0.840*	0.898*
Position 1st to 3rd	0.333*	0.476*	0.787*	0.877*
Position 4th to 8th	0.019	0.264*	0.684*	0.788*
Norway				
Combined results	0.161*	0.467*	0.820*	0.902*
Position 1st to 3rd	0.026	0.675*	0.866*	0.973*
Position 4th to 8th	0.008	0.105	0.613*	0.77*
USA				
Combined results	0.328*	0.528*	0.81*	0.913*
Position 1st to 3rd	0.371*	0.533*	0.719*	0.846*
Position 4th to 8th	0.182*	0.299*	0.617*	0.822*
All events				
Combined results	0.285*	0.581*	0.863*	0.911*
Position 1st to 3rd	0.271*	0.586*	0.818*	0.906*
Position 4th to 8th	0.096*	0.249*	0.648*	0.795*

Note: The higher the size of Kendall's tau-b rank correlation coefficient, the stronger the correlation: 0.0 to 0.2-weak, 0.2 to 0.5-moderately strong, and < 0.5 strong. The asterisks indicate positive statistical significance (*significant at P= 0.01, **significant at P= 0.05)

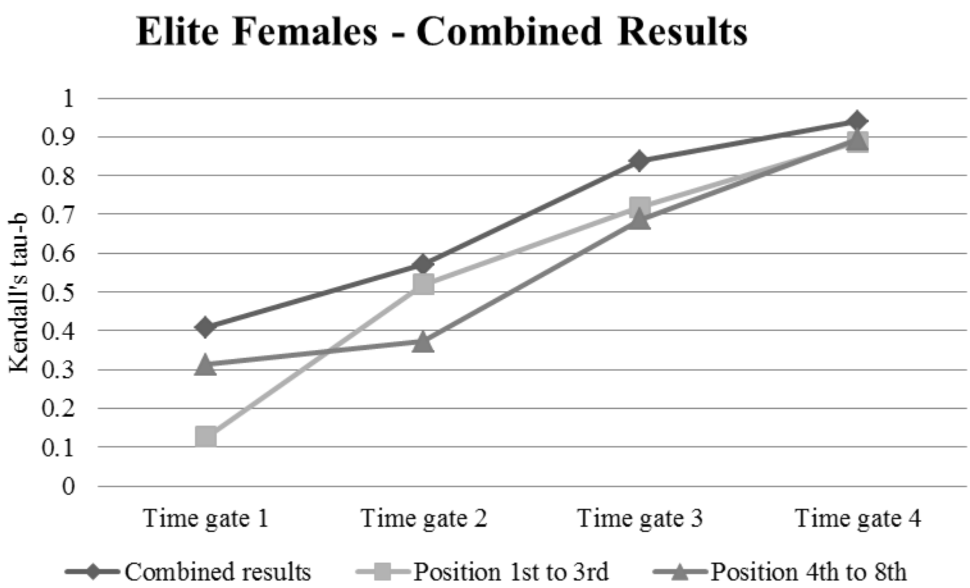

Figure 1. Combined Elite female positional correlation between all four start gate position and the finishing position at all four 2012 world cup races.

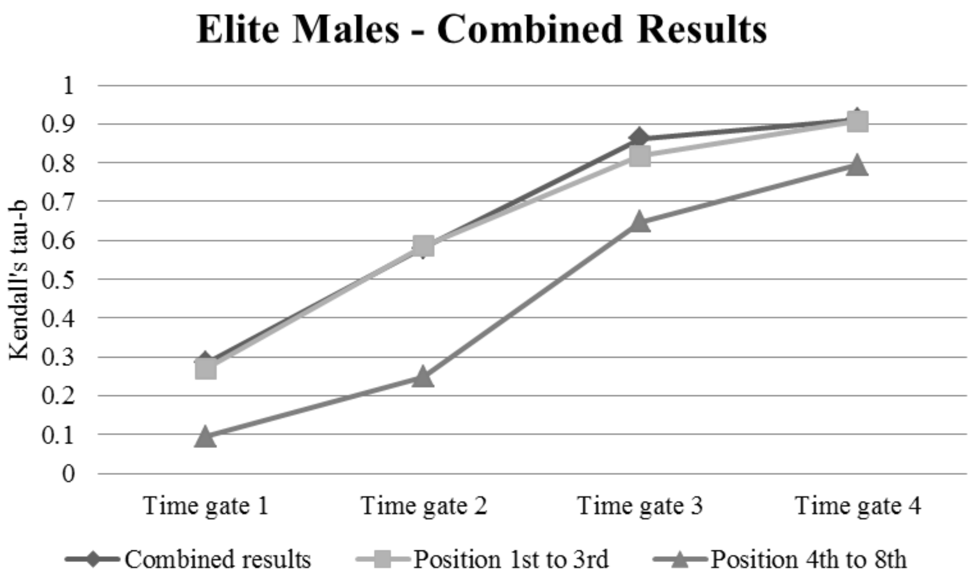

Figure 2. Combined Elite male positional correlation between all four start gate position and the finishing position at all four 2012 world cup races.

4. Discussion

The start is one of the key aspects of a BMX race, and has anecdotally been deemed by both coaches and riders as a determining factor for the eventual finishing position of a rider. Paradoxically, however, no previous research has been undertaken to establish whether this supposition is credible or not. It has been assumed previously that the riders with the most effective start will finish high in the results, as they seldom loose track position following the initial seconds of a race. The results from this particular study would suggest that this indeed may be the case. The analysis of 175 BMX races performed during four separate World Cup competitions revealed a significant positive correlation (see figure I & II) from time gate 2 through to the finishing line. The correlation increased in magnitude throughout the race and was present for both males and females. The correlation between the 1st to 3rd placed rider was significantly stronger at time gate 2 than for the 4th -8th position (males t= 0.586, P < .001. females t=0.519, P <.001) respectively. Similar findings were reported in all four competitions irrespective of track design and rider gender. This infers that the riders who produce the fastest start have a significantly greater possibility of finishing in the top three places at the end of the race. The results from the present study show that the first 8 to 10 s of a race has a statistically significant impact on the final outcome of a race (see table I).

However, the factors which determine the optimal BMX riders start, is still very much open to debate. One of the possible explanations is the torque, power, pedal rate relationship. The importance of the optimisation of torque, cadence and power in cycling disciplines has been reported in numerous studies (Dorel et al, 2005; Gardner et al, 2007; Herman et al, 2009; Debraux et al 2011; Debraux et al, 2013; Rylands et al, 2013). Understanding a BMX riders' optimal torque power pedal rate relationship at the start of a race may be a vital contributing factor for an effective start. The present study has recorded the importance of the first 8 – 10 s (see Table 2 & 3) of a BMX race which would appear to support the importance of torque, power and cadence.

Debraux et al (2013) analysed the relationship between torque and power pedal rate in seven elite BMX riders and concluded that torque was indeed a determining factor in the effectiveness of a BMX start. In the study of Debraux et al (2013) the riders perform an 80 meter sprint on a flat asphalt surface and peak torque, power and cadence where recorded using a strain gauge system, which was built into the rear wheel of the bicycle called PowerTap. The results from the study were used to extrapolate the theoretical optimal torque and power pedalling rate relationship. Unfortunately however, the actual relationship in a BMX race environment was not analysed. A similar study by Herman et al (2009) examined the importance of the power, pedal rate relationship in a BMX race environment. Herman et al (2009) recorded peak power (2087 ±156.8 W) occurred simultaneously with peak cadence (212 ±3.5 rpm) and was attained in the initial 1.6 s of the race. Based on the results from this study the power cadence relationship could have an effect on a BMX riders' finish line place as the relationship occurs in the first 1.6 s of a race. However, Herman et al (2009) did not measure torque, so the relationship between torque and power pedal rate has yet to be fully established in a BMX race environment.

The relationship between the above variables and the effect on a torque power pedal rate relationship at the start of a BMX race, may be worthy of future research. As demonstrated in this present study, the start of a BMX race is crucial and correlates to final position. Therefore, if the optimal torque power pedal rate relationship in the first 8-10 s of a race can be established, coaches and riders will be able to further focus their training methods, equipment choice and potentially collate credible data for talent identification and development purposes.

5. Conclusion

The results presented in this study demonstrate that the start in BMX racing is positively associated with a riders' finishing position. More specifically, the initial 8-10 s of a race are statistically correlated to the riders' finish line position. This largely associate effect was observed in both male and female races and irrespective of track design. The implications for BMX coaches are potentially vast. Due to the relative importance of the start a coach may choose to prioritise training to develop the physiological characteristics of a start over other areas of training. However, more analysis is required before any definitive conclusions can be drawn about the physiological contribution to enable an effective start. Performance characteristics such as torque, peak power, time to peak power and cadence need to be explored in future research and their effect on the start of a BMX race.

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