Original Article

Race analyses among Winter Olympic sliding sports: A cross-sectional study of the 2018/2019 World Cups and World Championships

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ABSTRACT

Studies about the three Olympic sliding sports are sparse, little is known other than factors related to start performance. Therefore, this study aimed to add to the current literature by analysing the race characteristics of the nine different events. A non-experimental retrospective method was applied to analyse all races of the 2018/2019 season. A total of 3371 race trials sampled across the sports of bobsleigh (n = 1105), luge (n = 1401) and skeleton (n = 865). Split rankings were correlated to finish rankings using Pearson product-moment correlation to analyse the relationship of sectional rankings and race outcome throughout the race. The results exhibited sequentially increasing correlation coefficients in all events. Yet, there were distinctive characteristics differentiating the sports. Bobsleigh illustrated correlations coefficients that at a minimum were very large (r ≥ .71) among all split rankings. Luge and skeleton depicted lower correlations for split 1 (r = .30 – .68) and thereafter substantially increasing as the race progressed. Thus, sliding performance can potentially have a greater impact in luge and skeleton than in bobsleigh. The differentiating race characteristics show the need for different training methods.

Keywords: Olympic sports; Bobsleigh; Luge; Skeleton; Performance analysis.

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INTRODUCTION

Considering Olympic sports, the sliding sports have received limited scientific attention. Alike other sports that have been able to benefit from scientific literature to advance the employed methodologies, similar efforts are needed to further develop the Olympic sliding sports. In the most recent Winter Olympics in 2018, it featured three sliding sports, bobsleigh, luge and skeleton. Altogether, totalling in 27 Olympic medals, across nine events among the sliding sports, an amount that will increase with the addition of women's monobob for the 2022 Winter Olympics (International Olympic Committee [IOC], 2018).

All three sliding sports reach maximal velocities greater than 100 km/h, with bobsleigh surpassing 150 km/h (McCradden & Cusimano, 2018). Bobsleigh and skeleton races are initiated with an overcoming of inertia by pushing the sledge. In luge, the athlete sits on the sledge and performs a pull-on stationary handle followed by paddles. The start performance in respective sliding sport heavily determines initial velocities, which may influence the remaining velocities and ultimately finishing time. The emphasis on starts in sliding sports is evident in the number of studies that concentrate on variables surrounding start performance in bobsleigh (Dias Lopes & Alouche, 2016; Osbeck et al., 1996; Peeters et al., 2019; Tomasevicz et al., 2018), luge (Crossland et al., 2012; Lembert et al., 2011; Platzer et al., 2009) and skeleton (Bullock et al., 2008; Colyer et al., 2017; Colyer et al., 2018a, 2018b). Studies researching overall race performance was only found to have been published twice across all three sports (Morlock & Zatsiorsky, 1989; Zanoletti et al., 2006). Morlock and Zatsiorsky (1989) studied bobsleigh performance, the researchers examined variables regarding environmental, time, order and velocity-based metrics. The results illustrated that ice temperature, start number and push-time significantly correlated with the final time. However, the study was limited due to only examining results at one track and thereby disallowing generalisations. In men's and women's skeleton, Zanoletti et al. (2006) used a bi-factorial approach comparing push-times with final race time. Once again, push-time correlated to final race time. Yet, the authors noted that push-time only explained 23% of the variance for men and 40% of the variance for women. Thus, there is a lack of scientific research regarding race analysis in luge. The research in bobsleigh and skeleton require greater sample sizes along with modern data.

The current disparity between research regarding start performance compared to that of overall race performance is clear. Therefore, further research to understand the intricacies of sliding sports is warranted. Consequently, this study aims to provide novel insight into the three Olympic sliding sports to better explain underlying race sections determining race outcome. Secondarily, the study aims to highlight the differentiating race characteristics.

MATERIALS AND METHODS

This study applied a retrospective cross-sectional design. Finish rankings among Olympic sliding sports were used as measures of performance outcome. While split rankings were used to analyse the trials' relative ranking within each respective race. By doing so, race progressions were enabled by analysing the sequential split rankings' relationship to finish rankings and event-specific race characteristics could be drawn.

Participants

In this study, all completed race trials from World Cup and World Championships from the 2018/2019 season were used as samples from the sports of luge, bobsleigh and skeleton. Overall, the sample consisted of 3371 race trials. Compared to similar studies' samples, race trials have amounted from 96 to 1857 (Morlock & Zatsiorsky, 1989; Zanoletti et al., 2006), resulting in an adequate sample size. In luge, men's singles (n =

565), men's double (n = 343) and women's singles (n = 493) were used as samples in this study. The team relay was not sampled due to its limited number of race trails. As for bobsleigh, two-man (n = 440), four-man (n = 401) and two-woman (n = 264) were included. Samples from skeleton were comprised of men's (n = 486) and women's (n = 379) race trials. All associative characteristics (i.e. name and country) was excluded from the data to preserve the anonymity of the athletes. Furthermore, the study was conducted in accordance with the Declaration of Helsinki.

Procedures

Due to availability, independency and continuity, official split rankings and finish rankings were retrieved for every race through the sports' respective international federation. It was concluded that time-based variables could result in inadequate measurements considering the variances between tracks (e.g. length, curves, etc.) and climate, the latter of which has illustrated affecting finishing times (Morlock & Zatsiorsky, 1989). On the contrary, rankings allowed for justifiable comparisons between races by cause of the split rankings consistently being dispersed throughout the track. Yet, it disallowed for exact proximity between rankings, as time differences may not be equal between sequential rankings.

Results for bobsleigh and skeleton were obtained from the joint International Bobsleigh & Skeleton Federation (IBSF). Results for luge were collected from the International Luge Federation (FIL). For bobsleigh and skeleton, five split rankings were used in the race results, while only four split rankings were available in luge. Trials that did not include complete split rankings or finish ranking were not included in this study.

Statistical analysis

Inferential statistics were used to analyse the variables using SPSS (SPSS Statistics 26, IBM, USA). The statistical significance level was set at $p < .05$. Bivariate correlations using Pearson's product-moment correlation were performed between finish rankings and the respective split rankings. Per Hopkins et al. (2009), the threshold guidelines for correlation coefficients (.1 = small; .3 = moderate; .5 = large; .7 = very large; .9 = extremely large) were used to determine the importance of each split ranking in relation to finish ranking.

RESULTS

All correlation coefficients were statistically significant at the .01 level (see Table 1). Furthermore, every event displayed a sequential increase in r value from the first split to the last, with the last split ranking correlation being extremely large ($r \geq .94$).

Table 1. Correlation matrix of split and finish rankings for Winter Olympic sliding sports.

Sport	Event	Split 1	Split 2	Split 3	Split 4	Split 5
Bobsleigh	Two-man (n = 440)	.76	.82	.88	.94	.98
	Four-man (n = 401)	.78	.84	.89	.94	.97
	Two-woman (n = 264)	.71	.75	.82	.89	.96
Luge	Men's singles (n = 565)	.54	.66	.78	.94	
	Men's double (n = 343)	.68	.78	.87	.95	
	Women's singles (n = 493)	.64	.77	.85	.95	
Skeleton	Men's (n = 486)	.63	.72	.83	.91	.97
	Women's (n = 379)	.30	.46	.72	.85	.96

All values are significant at the .01 level.

Bobsleigh

Two-man

The split rankings illustrated very large correlations (r ≥ .76) with finish rankings throughout the entire race progression for two-man bobsleigh. When reaching split 4 the correlations were extremely large (r ≥ .94) for the two remaining split rankings (see Figure 1).

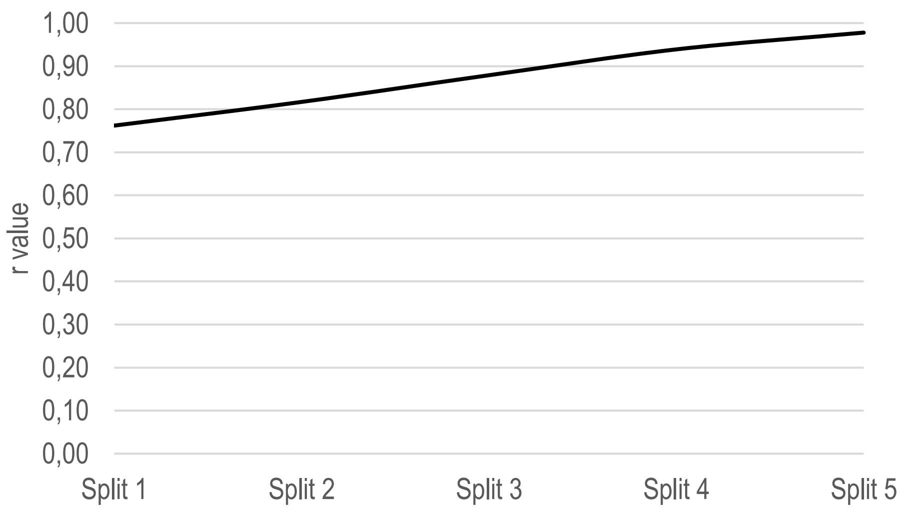

Figure 1. Graph illustrating the correlations between sequential split rankings and finish ranking in two-man bobsleigh (n = 440).

Four-man

Alike the aforementioned, a very large correlation (r ≥ .78) was pictured in all split rankings for four-man bobsleigh (see Figure 2). From split 3 to split 5 the correlations were almost extremely large (r = .89 - .97).

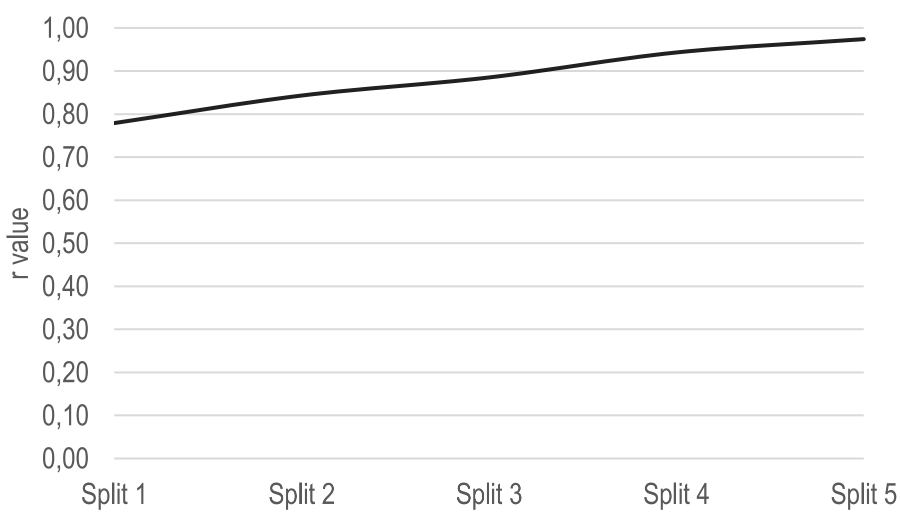

Figure 2. Graph illustrating the correlations between sequential split rankings and finish ranking in four-man bobsleigh (n = 401).

Two-woman

Correlations for two-woman bobsleigh showed that split rankings were less than extremely large through split 1 to split 4 (r = .71 - .89). The final split ranking split 5 correlated extremely large (r = .96) with finish ranking (see Figure 3).

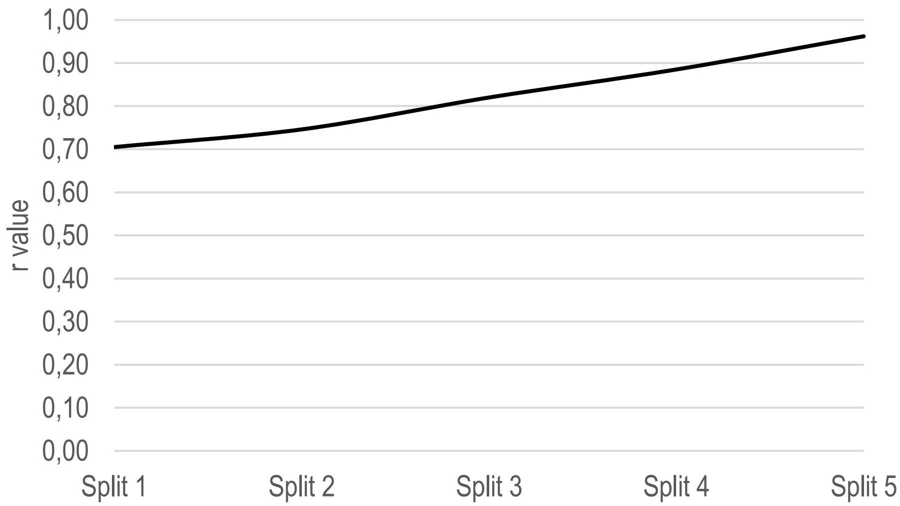

Figure 3. Graph illustrating the correlations between sequential split rankings and finish ranking in two-woman bobsleigh (n = 264).

Luge

Men's singles

Split 1 and split 2 depicted large correlation coefficients (r = .54 – .66) with finish rankings. At split 3 the correlation increased to a very large coefficient (r = .78), while split 4 correlated extremely large (r = .94) with finish rankings (see Figure 4).

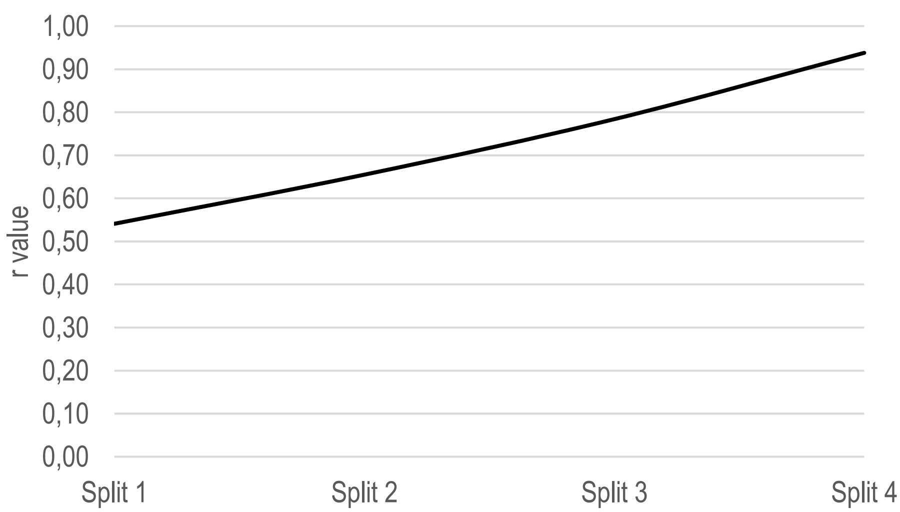

Figure 4. Graph illustrating the correlations between sequential split rankings and finish ranking in men's singles luge (n = 565).

Men's double

All split rankings for men's double nearly illustrated very large correlations (r ≥ .68) with finish ranking (see Figure 5). From split 2 to split 4, the correlation coefficient was either very large or extremely large (r = .78 - .95).

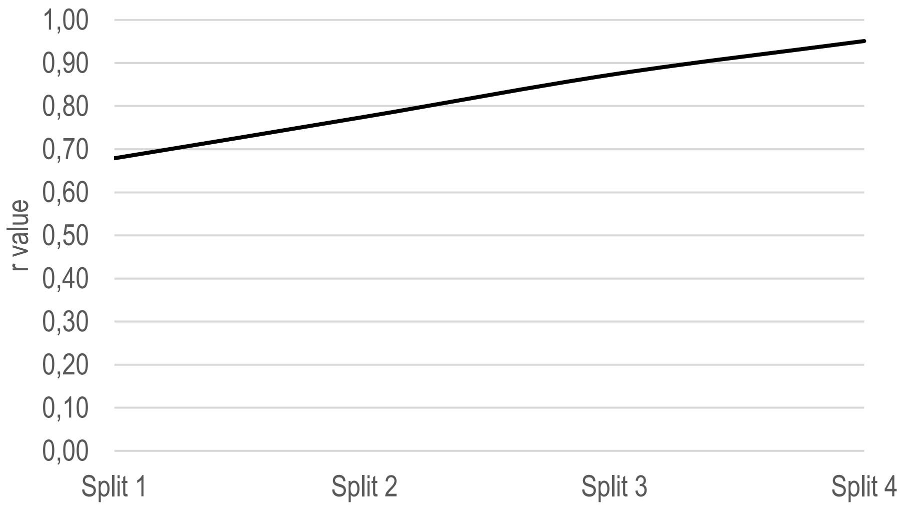

Figure 5. Graph illustrating the correlations between sequential split rankings and finish ranking in men's double luge (n = 343).

Women's singles

The correlation coefficients of women's singles luge were similar to the other events in luge, with an initial large correlation (r = .64) at split 1 (see Figure 6). Then followed by a very large (r = .77 - .85) and extremely large correlation (r = .95).

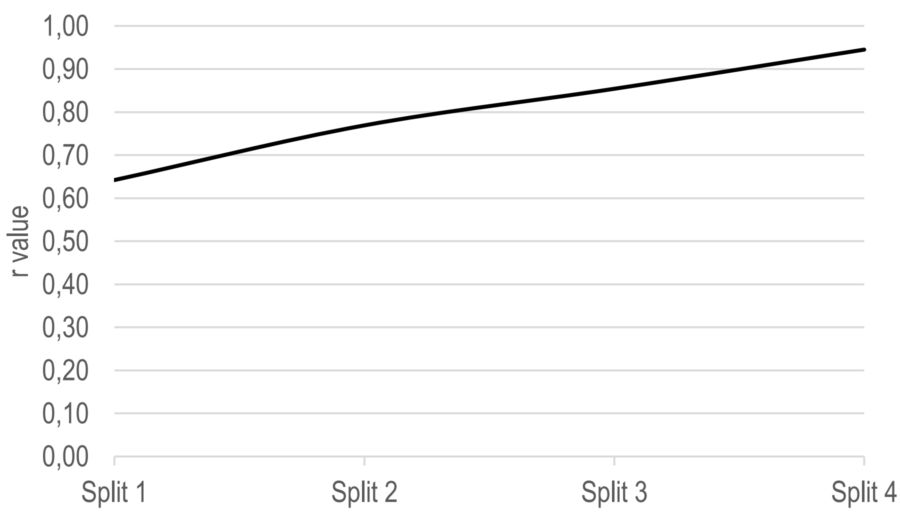

Figure 6. Graph illustrating the correlations between sequential split rankings and finish ranking in women's singles luge (n = 493).

Skeleton

Men's

All of men's skeleton split rankings showed moderate or greater correlation coefficients (r ≥ .64). Both split 4 and split 5 illustrated extremely large correlations (r = .91 - .97) to finish ranking (see Figure 7).

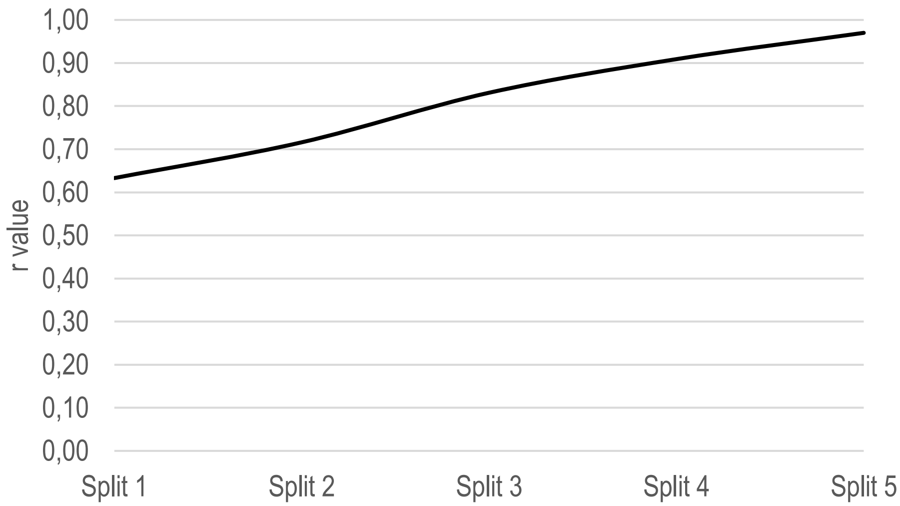

Figure 7. Graph illustrating the correlations between sequential split rankings and finish ranking in men's skeleton (n = 486).

Women's

Split 1 and split 2 depicted moderate correlation coefficients (r = .30 - .46) for women's skeleton. The three following split rankings resulted in a very large (r = .72 - .85) and extremely large (r = .96) correlation coefficients (see Figure 8).

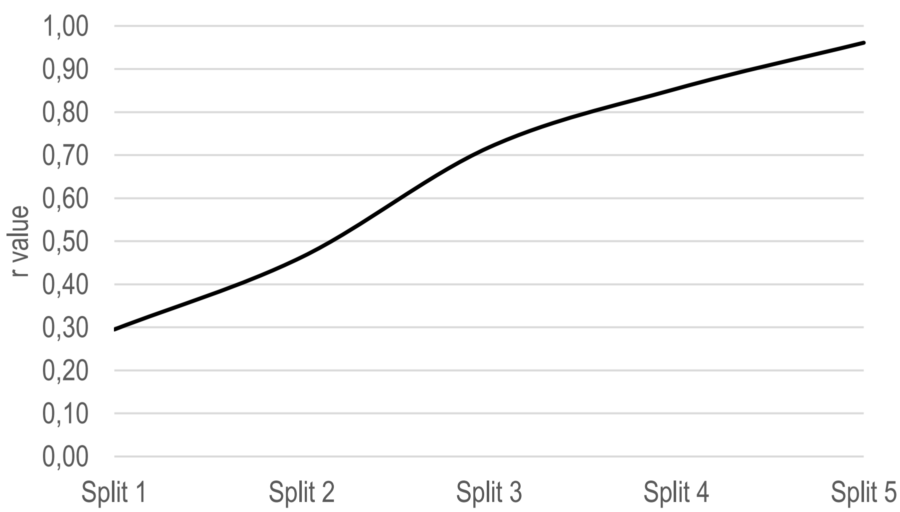

Figure 8. Graph illustrating the correlations between sequential split rankings and finish ranking in women's skeleton (n = 379).

DISCUSSION

The primary aim of this study was to provide novel insight into the three Olympic sliding sports to better explain underlying factors determining race outcome. The main findings in this study include the various correlation coefficients of sequential split rankings exhibited in each respective event. Consequently, split rankings may highlight decisive sections and influence training methodologies.

Race characteristics

Bobsleigh

All bobsleigh events illustrated similar results, an initial correlation coefficient that emphasises the need for a good start to allow for a much greater chance of achieving a higher finish ranking. Compared to previous literature (Morlock & Zatsiorsky, 1989) similar results have been presented and therefore enhance the probability of start significance in bobsleigh. The need for a good start is evident among the male bobsleigh events, both two-man and four-man prove relatively even correlation coefficients throughout the sequential split rankings. Thus, male pilots are generally not able to sufficiently influence the finish ranking with their driving to the extent of positively ascending in ranking. Conversely, pilots' driving may not affect the bobsleigh to change negatively in ranking to a high degree. Female pilots in two-woman bobsleigh demonstrate a greater possibility to affect the race at the initial sections. However, they may still experience difficulties in influencing finish ranking after split 1 and extensively more difficult from split 3 and onward.

Luge

It may be established that the first sections of a luge race influence finish ranking. However, the results illustrate that the latter half of the race heavily determines race outcome. Of the three luge events, men's singles exhibit the greatest possibilities for influencing finish ranking throughout the race. Specifically, the beginning of men's single races does not reflect race outcome to a very large degree. The beginning of the race may instead represent a change in race rankings ahead of the greater determinants noted in the final two splits. Nonetheless, a fast start will lessen the need to improve race ranking in any drastic manner. Still, an uncontrollably fast start may lead to a descending ranking until the latter sections of the race where the potential influence has decreased considerably.

Skeleton

The two skeleton events exhibited different characteristics. Men's skeleton illustrated relatively linear increases in correlation coefficients throughout the sequential split rankings, closely replicating those seen in the other sliding sports. Women's skeleton depicted moderate correlation coefficients at the beginning of the race and thereby allowing for substantial changes in race ranking. Thus, the initial sections may not adequately explain race outcome and the decisive sections occurs past the midway point of the race. Alike previous literature (Zanoletti et al., 2006), the start correlated to the finish performance, but as the authors noted, the start may not fully reflect the race outcome. By increasing the number of sections that were examined, the results showed that the latter sections were highly influential in determining race outcome. Therefore, the value of a high ranking start in women's skeleton is somewhat reduced.

Practical implications

Luge and skeleton demonstrate similar race characteristics, an early indication of race outcome coupled with considerably determining split rankings in the second half of the race. So, in addition to start training, preparations should in large part revolve around the skill of sliding and specifically the skill of sliding at initial race velocities. Both physical and psychological skills that are trainable without an ice track may benefit the athlete's preparation ahead of sliding. Currently, no studies regarding physical or psychological performance indicators for the skill of sliding in either sport is available. However, the relevancy of psychological capacities such as attention-focused strategies, anxiety coping and mental preparation have been noted to explain driving performance in automobile racing (Ebben & Gagnon, 2012; Filho et al., 2015; Potkanowicz & Mendel, 2013). Thus, it may be speculated that comparable attributes will contribute to sliding performance, but further research is necessary.

The three different events in bobsleigh all highlighted the importance of a top-ranked start in relation to finish ranking. Previous research suggests that power, speed and strength variables are decisive in bobsleigh team selection (Osbeck et al., 1996; Tomasevicz et al., 2018). Therefore, a physical development program focusing on the suggested variables may be recommended to improve start performance in bobsleigh. Nonetheless, the results did not show a large enough correlation to overlook the importance of driving a bobsleigh. Similar methods to improving sliding skill in luge and skeleton may be implemented to improve the skill of driving a bobsleigh.

CONCLUSIONS

This study allowed for novel knowledge that supplement the current literature in Winter Olympic sliding sports. There are notable similarities and differences in race characteristics between the sliding sports. First, all events exhibit a sequential increase in interrelationship between split rankings and finish ranking. Second, events differentiate in the importance of initial split rankings in relation to race outcome. Further studies are necessary to gain a detailed understanding of sliding sports and the factors that relate to sliding performance. By doing so, practitioners can draw from research-based methods to improve sports performance.

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DISCLOSURE STATEMENT

There have not been any conflicts of interests in this study.

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