ON GENDER DIFFERENCES IN THE REACTION TIMES OF SPRINTERS AT THE 2008 BEIJING OLYMPICS

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INTRODUCTION

The International Association of Athletics Federations (IAAF) rules stipulate that a reaction time of less than 100 ms constitutes a false start for sprinters. Mero and Komi showed the mean reaction time from the gun signal to 10% force production on the starting block in eight national-level Finnish male sprinters was 119 ms [1]; the reaction time of female sprinters was not measured. Gender differences have been noted in reaction times in other sports such as handball [3]. In this paper we address three questions. Q1: Is there a gender difference in the reaction times of world-class sprinters? Q2: What is the absolute minimum reaction time that is humanly possible for elite male and female sprinters? Q3: How do those minimum reaction times compare with the 100 ms IAAF threshold criterion? To answer these questions, we used published reaction time data from the 2008 Beijing Olympics and tested the null hypothesis that no gender difference exists in the reaction time of world-class sprinters.

METHODS

The reaction time data were collected from the official results website for the 2008 Beijing Olympics for men and women's 100 m, 200 m, 400 m, and 100/110 m hurdles. Reaction times from the heats, quarterfinals, semifinals, and finals were included in the analysis as a 'round' factor. Since sprinters (always identified by the same bib number) could participate in multiple individual races or advance in a race to participate in multiple rounds of an individual race, we could not consider such data to be independent. Therefore, simple statistical analyses such as a t-test or ANOVA without repeated measures are not appropriate.

The statistical analysis was performed using SPSS 16.0 (SPSS Inc., Chicago, IL). Since the data are right skewed, they were power-transformed and normality was then confirmed with the Shapiro-Wilk test. A linear mixed model was then used to analyze the transformed reaction time data. Gender was treated as a fixed factor, and Race(Bib ID) and Round(Race) were treated as random factors. The random factors allowed our statistical model to handle the lack of independence in the reaction time data. A type III test of fixed effects was used to investigate the gender effect. We defined the minimum simple reaction time (SRT) that is humanly possible for an Olympic sprinter to achieve in 1 out of 100 races to be the [mean-2.576*SD] value, a value that was found for each gender by using a Taylor expansion while back-transforming to the original temporal scale.

RESULTS AND DISCUSSION

The reaction times for male and females sprinters are shown in a histogram in Figure 1. The linear mixed model showed the fixed effect of gender was significant ($p<0.001$). Analysis of the random factors showed different races and different rounds accounted for 29% and 33% of the variability in the mean reaction time.

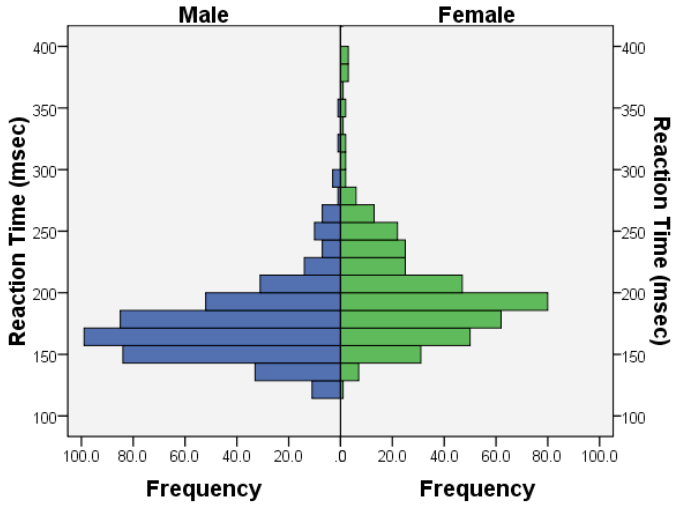

Figure 1. Population pyramid showing reaction times for male and female sprinters (original scale).

The estimated marginal mean for male sprinters was 168 ms with a 95% confidence interval of 160 ms to 178 ms. The estimated marginal mean for female sprinters was 191 ms with a 95% confidence interval of 180 ms to 205 ms. The estimated absolute minimum SRT value was 124 ms for males and 130 ms for females, values. Interestingly, male sprinters had 25 false starts in Beijing, while females only had 4 false starts, reflecting their 6 ms larger margin identified in this paper.

A previous study used reaction time from the official results of international sprinting competitions [3] and showed the mean reaction time for male sprinters increased as a function of the race length and decreased as they advanced through the heats to the finals. Furthermore, there was no difference in the reaction time in less experienced sprinters. Despite these findings, their study had major limitations. First potential gender differences were not examined. Second, a Gaussian distribution for the reaction time data was unfortunately assumed (Figure 1). Lastly, independence of data points was assumed (via use of a one-way ANOVA), an incorrect assumption for this data set.

Our results show a strong gender difference in sprinters participating in the 2008 Beijing Olympics. Another previous study showed a gender difference in the reaction times of sprinters in the 100/110m sprint events at the 2004 Olympics [4]. However, that study focused on lane position effects rather than gender in their statistical model. Multiple measurements were used from the same athlete as long as they were in different lane positions for each race. The use of an analysis of variance without data transformation is not as robust a statistical model for investigating gender differences as the present linear mixed model using transformed data.

This is the first time that an accurate estimate of the 6 ms gender difference in the minimum SRT of elite world-class sprinters has been reported. This result suggest that the criterion for a false start may need to be raised from the present 100 ms for female sprinting competitions to account for inherent gender differences in reaction time between males and females. A potential explanation for the gender difference may be a difference in how the central nervous system of each sex deals with stressful time-critical situations. For example, healthy young adult females have also shown significantly longer upper extremity reaction times than males when manually raising the arms to block a foam ball projected directly at their face at a high speed [5].

The consequences of false starts are greater for sprinters in the Olympics than for the sprinters in the Mero and Komi study. This helps explain why the present mean male reaction time is longer than theirs.

The limitations to our statistical analyses include the point that we only examined gender as a fixed factor. We could include age as another factor, but previous work showed no age difference [3] and including the age factor would have lowered statistical power. We did not included height and weight as covariates because these data are not publically available online. Finally, the Taylor expansion used in the minimum SRT analysis is only an approximation; a bootstrapping method might be a superior approach.

CONCLUSIONS

1) There is a significant gender difference in the mean reaction time for elite sprinters.
2) The minimum (humanly) possible reaction times for world-class male and female sprinters are 124 ms and 130 ms, respectively.
3) These minimum possible reaction times are as much as 24 ms (24%) and 30 ms (30%) longer than the official IAAF 100 ms criterion.
4) There should be different false start criteria for men and women.
5) False start criteria should be based on data from world-class athletes taken in actual competition.

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