Study of Balance During Weight-Shifting for Standard Indoor Rowing

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Abstract

In this paper, the lateral weight distribution of amateur and experienced rowers is compared through utilization of a force-measurement plate (Wii Board) and LabVIEW Analytic Software. Two different methods of experimentation were utilized: (1) the comparison of amateur and experienced rowers through their respective lateral weight distributions and (2) a measurement of the amateur rower's lateral weight distribution improvement over time in comparison to their baseline measurements. An analysis of results obtained from the subjects[redacted], is also included.

Introduction

Rowing, also known as "crew" in North America, has been a sport for centuries and utilized out of necessity throughout history prior to the invention of the motor. Within the scope of rowing within a racing shell (competitive rowing), there are a multitude of factors that affect the "set" of the shell, ranging from hand positions of individual rowers to the weight distribution of each rower along the lateral (horizontal – left/right) and vertical (forward/backward motion) planes. By adjusting the "set" to the center of balance for a boat, this allows for the boat to move faster and more efficiently holistically. Although this concept is more pertinent in racing shells in water, this concept also transfers to indoor rowing on ergometers (referred to commonly as "ergs"), as the seating configuration is the same, as well as, the motion difference is minimal and only slightly swung to one side or another. Ergs do not slow or strain due to weight distribution changes unlike in racing shells; however, the tendencies of a rower are retained during indoor (erg) rowing. The intention of the experiment was to find a suitable technique to measure the weight distribution of individual rowers through utilization of an erg to minimize other external factors. As the old saying goes in rowing, "no one is a prodigy in rowing and everyone only gets better with experience"; to test this phenomenon, an experienced rower ([redacted]) was compared to an amateur rower (Isaaq F) in terms of weight distribution.

The first goal of this experiment was to minimize costs of the experiment through utilization of technologies accessible within the Physics of Living Systems Lab or that could be ordered for less than $100 generally. Access to a camera phone, laptop, and Wii Board were required to allow for interpretation of data. Cost minimization was considered for the Wii Board Apparatus, in which a Wii Board was placed upon a wooden panel for stabilization and foam was applied to the sides of the panel to minimize contact between the participant and the apparatus. The second goal of the experiment was to compile weight distribution data from both an experienced rower and an amateur rower with the purpose of seeking a result.

Methods

After a discussion of proper rowing technique, two hypotheses were formulated. Firstly, a more experienced rower will have less variability between individual strokes and a “more-centered” center of mass about their stroke in comparison to an amateur, who would have larger variation in force distribution between strokes and a “less-centered” (more laterally significant) center of mass. Secondly, if an amateur rower spends more time rowing in a single workout, then their representative mean forces distribution for lateral force distribution will be more centralized over time thanks to improvement in scaling of each stroke.

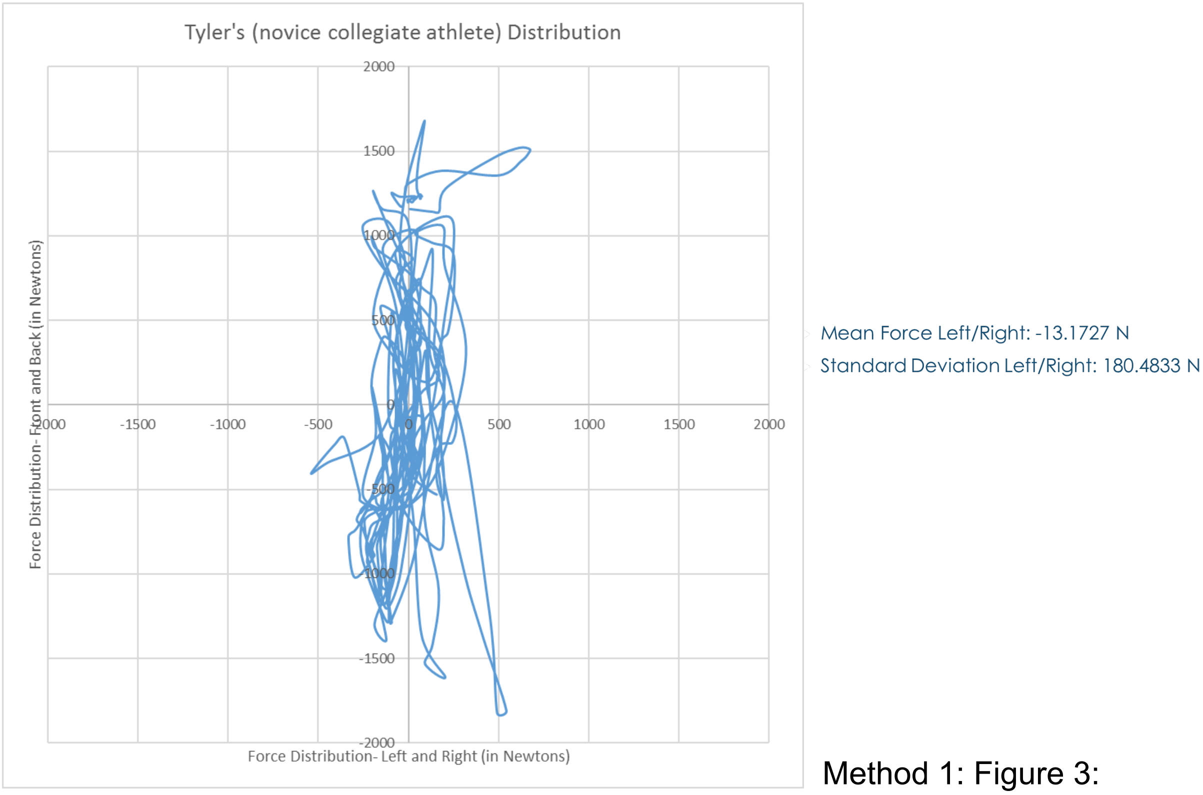
In terms of experimentation, the Wii Board apparatus [1] was placed upon the ergometer and two methods of data collection were utilized, one for each of the hypotheses:

1. Corresponding to Hypothesis 1: Row for 30 seconds, while holding a constant 24 stroke/minute rate, any wattage allowed for power output, only 1 attempt allowed.
2. Corresponding to Hypothesis 2: Row for 120 seconds, while holding a constant 24 stroke/minute rate, any wattage allowed for power output, only one attempt allowed. Shown proper rowing technique again and shown distribution data during the row to judge self-correction of force distribution.

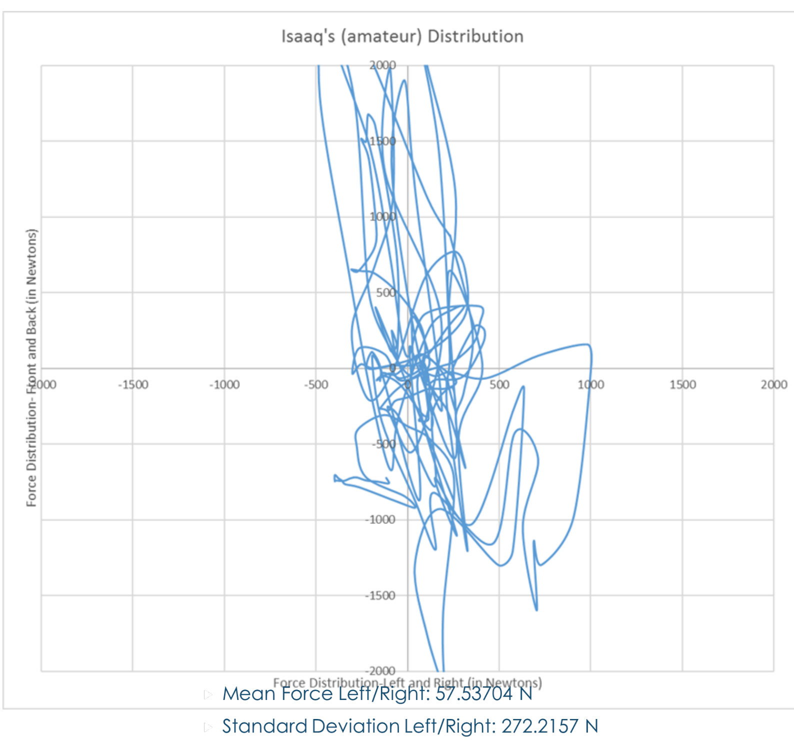
With the Wii Board acting as an input device of force distribution, data was recorded by LabVIEW and exported to Microsoft Excel for interpretation. In Method 1 Testing, [redacted] acted as the experienced rower and proceeded first, followed by [redacted], who was the amateur rower participant.

Results

Method 1: Figure 2: *(Negative x-values are indicative of left force distribution and Positive x-values are indicative of right force distribution; Negative y-values are indicative of backwards motion and Positive y-values are indicative of forwards motion)*



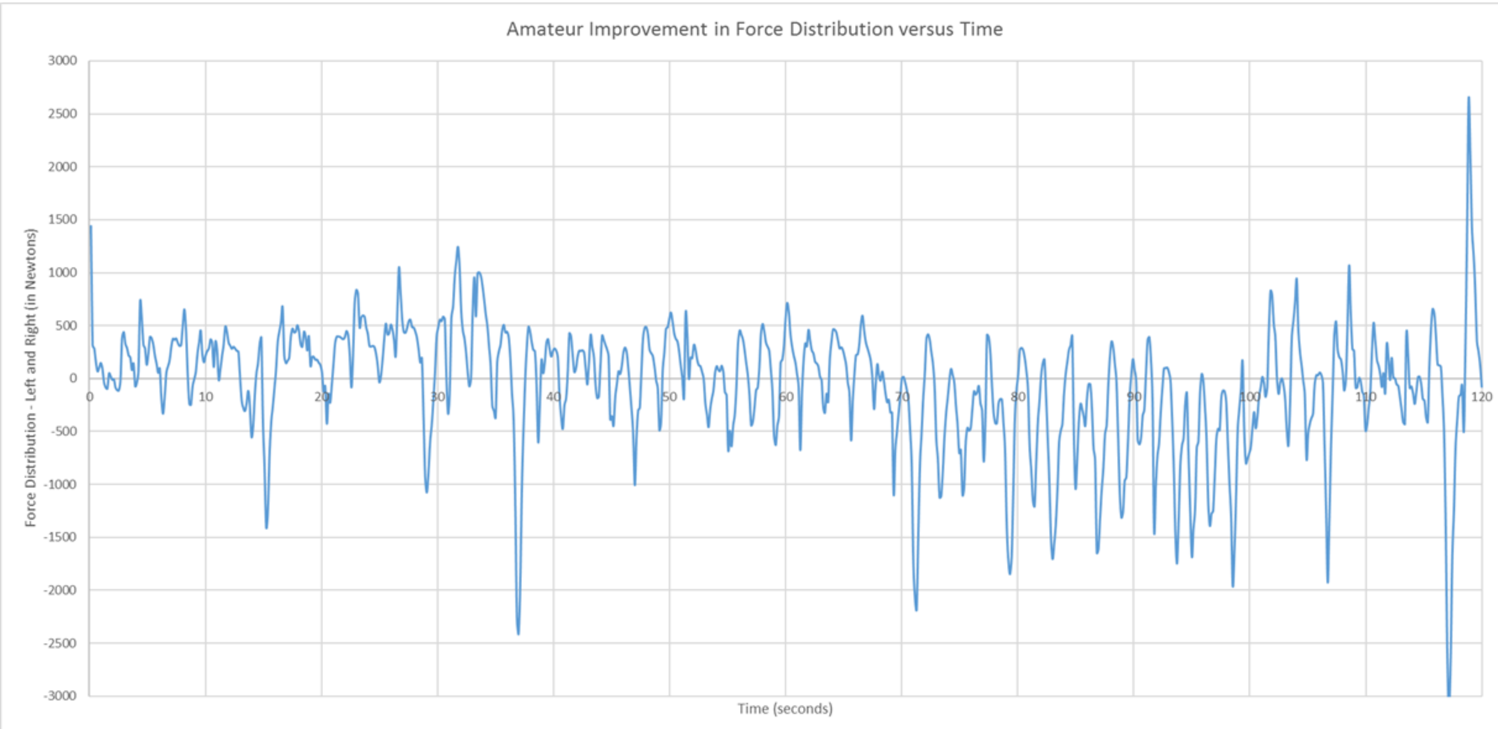
Method 1: Figure 3: *(Negative x-values are indicative of left force distribution and Positive x-values are indicative of right force distribution; Negative y-values are indicative of backwards motion and Positive y-values are indicative of forwards motion)*



Method 1: Figure 4: Comparison of Experienced versus Amateur Rower

	Tyler (Experienced Rower)	Isaaq (Amateur Rower)
Mean Force (L/R)	-13.1727 N	57.53704 N
Standard Deviation	180.4833 N	272.2157 N

Method 2: Figure 5: Amateur Rower's Force Distribution over Time
(Negative y-values represent rightward motion and Positive y-values represent leftward motion)



- Mean Force Left/Right: -61.000 N
- Standard Deviation Left/Right: 570.6114 N

Conclusions

Since Tyler (experienced rower) had a “more-centered” center of mass (as described by mean force L/R in Figure 4) and a smaller standard deviation (which represents that variability of force distribution between strokes) in comparison to Isaaq (amateur rower), Hypothesis 1 was supported. In terms of Method 2, since Isaaq (amateur rower) showed little to no improvement over time in force distribution over the 120 seconds (as seen in Figure 5), no improvement was observed in the short term, thus Hypothesis 2 was refuted. If this experiment were conducted again, Method 2 should be replicated over a certain length of interval in time to allow for improvement; improvement in the short term was unlikely due to the capacity of muscle memory. In addition, a potential experimental condition would be to compare a Port-sweep rower to a Starboard-sweep rower and look at force distributions, as these should have opposite directional force distributions from one another.

Appendix

A. Figure 1: Wii Board Apparatus