The Analysis of 2D Rowing with Ergometer Rowing Kinematics

Angga Muhamad Syahid, Agus Rusdiana, Raden Boyke Mulyana, Dede Rohmat Nurjaya and Yopi Kusnidar
Universitas Pendidikan Indonesia, Jl. Dr. Setiabudhi No. 229, Bandung, Indonesia
angga.m.syahid@student.upi.edu

Keywords: Kinematic, Ergometer, Rowing.

Abstract: This research aims to analyze the movement kinematic between rowing and ergometer on the state of catch and drive when the first row is done on the star. The samples are 8 national rowing team athletes (males). The rowing movement was recorded using slow motion video recorder. The movement kinematic data was analyzed using Dartfish 7 software, and then the result of the rowing and ergometer analysis was tested using the T-test independent sample. There is a significant difference between the angle knee joint rowing with the ergometer during the state of catch. There is a significant difference between the leg velocity rowing and ergometer during the drive phase. There is no significant difference between the leg velocity rowing and ergometer during the drive phase. The analysis of movement kinematic shows that there is a different movement during the catch and drive phase of the rowing techniques which was implemented by the samples and leg velocity is the only thing that doesn't change.

1 INTRODUCTION

All this time, the rowing training aims to modify the training so that the rowing technique could develop in increasing the speed of the rowboat on the water. The training program on land is often designed to simulate the rowing movement similar to what is done on the water (Lamb, 1989). An ergometer is a simulation tool on land that is often used in predicting the performance of rowing movement on the water (Mikuli, Smoljanovi, Bojani, Hannafin, and Branka, 2000) and becomes a popular training equipment in rowing. The ergometer is an equipment (simulator) which is considered as efficient in rowing training specificated on land, it even can be used as media talent scouting, to look for the best rower (Elliott, Lyttle, and Birkett, 2007). Another research shows that the ergometer helps training the rowing movement using the consistent and efficient energy (Anderson, Harrison, and Lyons, 2007).

Understanding how the physical and biomechanic factors affect the rowing performance is really needed, as rowing is a measured sport in which the time between the winners of the competition can only have split second difference (Alexandre Baudouin and Hawkins, 2004). All this time, there have been so many research about the rowing performance based on the physical factors. (Whyte and Nevill, 2002) (Bell, Bennett, Reynolds, Syrotuik, and Gervais, 2013) (Kinetics, Iii, and Training, 2014). Aside from the physical factors, the success in rowing sports needs a strong biological system (of the rower) and a well-designed and efficient mechanical system, which maximizes that biological system (A Baudouin and Hawkins, 2002). Some research that have been conducted about the mechanical and biomechanical system in rowing (Hofmijster, Landman, Smith, and Soest, 2007) states that the rower's mechanical movement can cause the loss of speed on the boat, (Anderson et al., 2007) and it also states that the rowing performance can be affected by the inconsistency of the rower's mechanical movement.

A rower who has a good physical ability, does not necessarily have a good performance as well when they rows on the water (Kleshnev, 2009), this is because the inefficient rowing technique used by the rower. Therefore, there are so many research conducted about the technique efficiency in the terms of mechanic, biomechanic, and kinematic, on rowing and ergometer as the training simulator equipments, (Marcolin, Lentola, Paoli, and Petrone, 2015) state that there are differences on the force resulting from the rowing process using rowing and ergometer,

Syahid, A., Rusdiana, A., Mulyana, R., Nurjaya, D. and Kusnidar, Y.
The Analysis of 2D Rowing with Ergometer Rowing Kinematics.
In *Proceedings of the 2nd International Conference on Sports Science, Health and Physical Education (ICSSHPE 2017) - Volume 2*, pages 136-141
ISBN: 978-989-758-317-9

(Janshen, Mattes, and Tidow, 2009) state that the acceleration from the feet section on ergometer is the most important part in training the force efficiency which is applied in rowing on the water. Based on many literature discussing mechanics, biomechanics, and kinematic on the rowing and ergometer performance, this research aims to analyze the movement kinematic between rowing and ergometer on the catch and drive phase when the first row is done in the beginning.

2 METHOD

2.1 Design and Participants

This research uses the descriptive comparative method with the samples of 8 male athletes from Indonesian national team that have 4 years of rowing experiences (± 2 years).

2.2 Measures

Slow motion video recorder. The slow motion video was taken using the professional camera, Panasonic HC-WX970 4k Ultra HD.
Rowing and Ergometer. The rowboat used was the wintech single scull and ergometer used was the ergometer concept 2.

2.3 Procedure

Data collection. The video was taken vertically when the athletes were doing the rowing and ergometer movement in Figure 1.

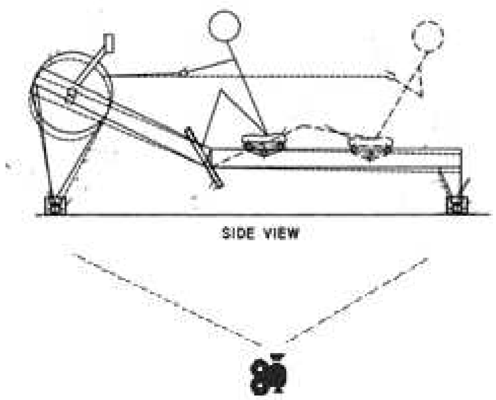

Figure 1: The angle of the slow motion video recording.

The ergometer and rowing tests. The athletes start rowing with efforts and strokes when they are on the game, whereas on the ergometer the athlets are rowing for 1 minute in accordance with the stroke start when they are in a game, on the water. The analysis of the video data that was taken is that the first row on the start.

2.4 Data Analysis

The data is the slow motion video that was analyzed using the Dartfish 7 Motion Analyzer. After that, to analyze the differences statistically, independent sample T-test was used through SPSS 21 with the level of probability of 95% (alpha level set 0.05).

Figure 2: Angle knee joint ergometer and rowing.

There is a significant difference on the arm velocity rowing with the ergometer on the drive phase (t = 15,887 p = 0.000). There is no significant difference on the leg velocity rowing with the ergometer on the drive phase (t = 1,228 = 0.240).

Table 1: Data descriptive.

	Mean ± SD
Ergometer angle knee joint (n=8)	25.89 ± 4.641
Rowing angle knee joint (n=8)	30.34 ± 0.226
Arm velocity ergometer (n=8)	1.16 ± 0.103
Arm velocity rowing (n=8)	0.48 ± 0.064
leg velocity ergometer (n=8)	0.298 ± 0.072
leg velocity rowing (n=8)	0.265 ± 0.030071

3 RESULTS AND DISCUSSION

From the research's result, it is discovered that the difference between angle knee joint that was formed during the catch phase on the ergometer and rowing is significant. This shows that the movement technique that was done by the athletes on the catch phase hadn't showed the real movement of rowing. This result can also identify that force (effort) that was generated by the athletes is no more than that on the rowing because th average angle formed on the ergometer (25.8°) is smaller than the average angle on the rowing (30.3°). This is related to the explanation that the bigger the angle formed by the knees on the catch phase, the more the energy that can be generated by the muscles that work as the lever on the legs

(Nolte, 2011). Figure 3 shows that not all athletes can make knees' angles that tend to be smaller on the ergometer than the rowing. Some athletes get different results but the angles formed on the ergometer come close to the angles on the rowing (std dev 4.6).

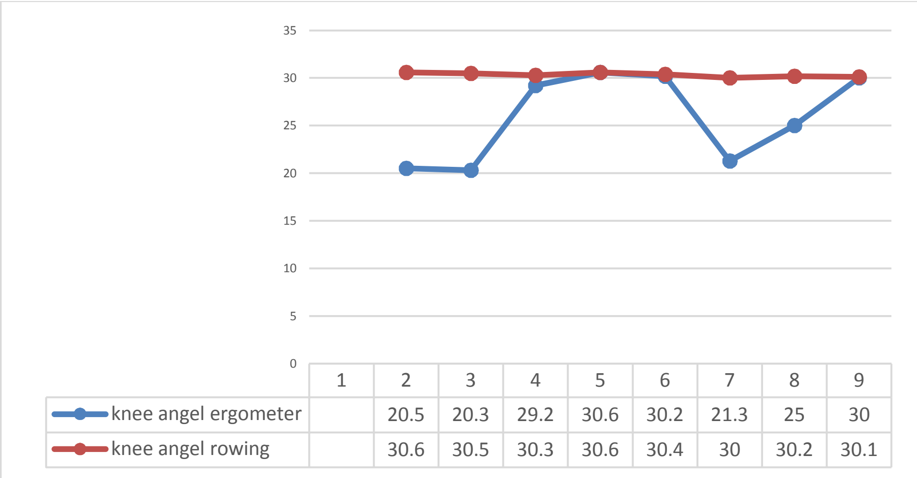

Figure 3: The comparation of knee joint angle on catch phase.

It shows that samples number 3, 4, and 5 have the knees' angles that are almost the same between the ergometer and rowing, it is indicated the technique efficiency for sample 3, 4, 5 better than the other samples in accordance with the theoretical review in which the bigger knees' angles can generate bigger force on legs push on the drive phase. Moreover, samples number 3, 4, and 5 are national athletes that had gotten achievements on the international level, gold medals on the SEA GAMES 2013 and 2015, compared to samples number 1, 2, 6, and 7 who just got achievements on the national level.

It is discovered that the difference between arm velocity on the drive phase that was generated on the ergometer and rowing is quite significant. It indicates that technique movement that was being done by the athletes during the drive phase when they did the hands pull had time interval and space differences (v = space/time). This result has an important affect on the drive phase in which the long interval of time gives large resistance effect on the boat's speed, because with the longer the athletes do the pulls on the drive phase, the longer the oars stay in the water, Figure 4 shows the arm velocity for each athlete on the drive phase.

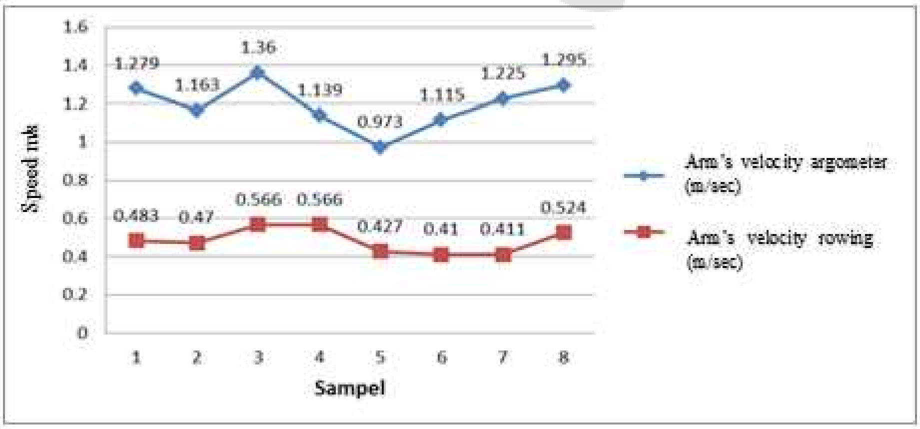

Figure 4: Arm velocity rowing and ergometer.

Figure 4 shows that the pulling speed on the ergometer has a greater speed (m/s) compared to the rowing. This result also supports the research that states that anthropometric (arm's length) also has effect on the speed, as the arm's length become farther when the drive is done on stroke. This comparation of length can be seen in Figure 5.

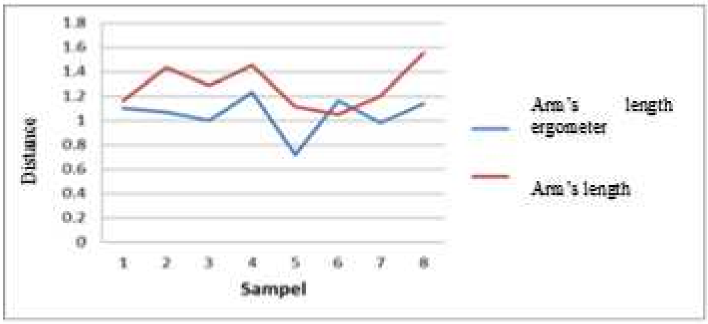

Figure 5: The comparation of the arm's length.

Figure 5 shows that the arm's length on the rowing is greater/farther compared to the ergometer. This data also identify that there will be differences of force on rowing and ergometer because the distance and speed that are generated are different.

The former two kinematic indicators show state that the difference on angle knee joint and arm velocity, whereas on the leg velocity, the result is that there is no difference on the speed between rowing and the ergometer. There are just some athletes that generate different speed between rowing and ergometer, and that result can be seen in Figure 6. If it's linked to the angle knee on the first hypothesis, the leg velocity result can indeed be a concern, since the greater angle can generate greater force.

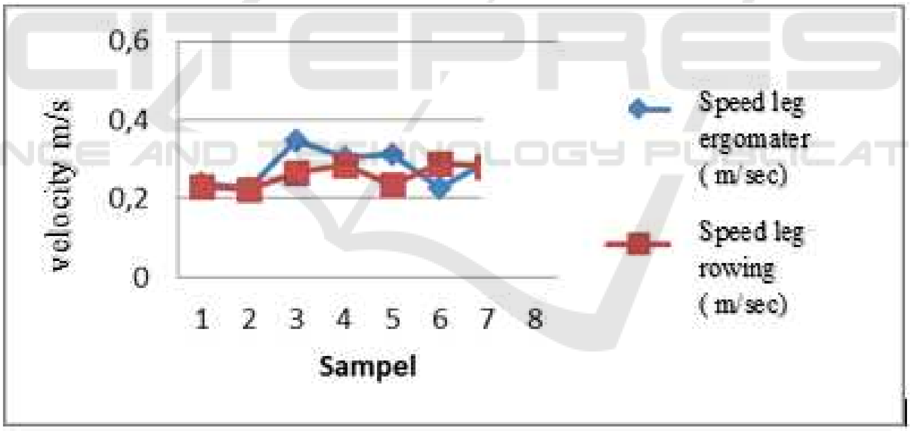

Figure 6: The comparison of leg velocity on drive phase.

Having a great angle as possible can lengthen the feet drive and increase the muscle mechanism in generating force (Nolte, 2011). So that basically, athletes that make little angles can generate greater force if they are capable of making the greater angles since there is no speed difference between the rowing and the ergometer. Next, Figure 7 below shows the average result from the leg velocity on the drive phase.

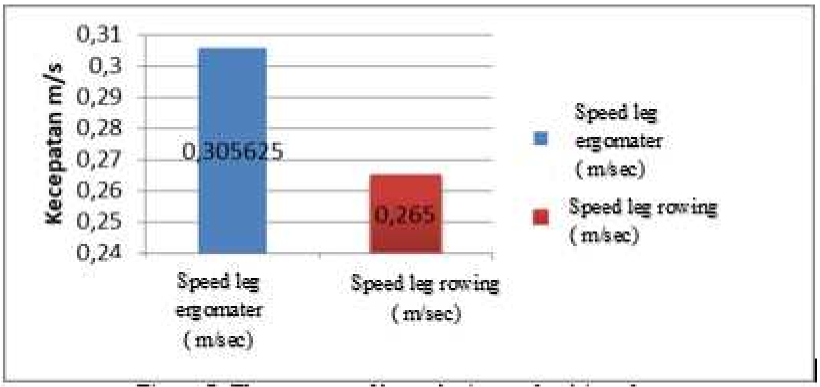

Figure 7: The average of leg velocity on the drive phase.

From Figure 7 above, it is discovered that the average result of the speed of the feet on the ergometer is greater (0.3056 m/s). It is because the speed of each athlete's feet when they push on the catch phase are different, so that the average obtained is also different, even though the result of each athlete's speed don't have any differences. This is caused by the different feet's length of the different athletes and is supported by the first research's hypothesis stating that the result of the angle formed by each athlete is also different.

4 CONCLUSIONS

This research analyzes the kinematic of single rowing and ergometer rowing in two dimensions, the body's segments and velocity in a simple way, analyzed on the catch and drive phase. This research is one of the reviews that supports the efectivity of the techniques done on the rowing as the evaluation technique for both coach and athletes or for the parameter in measuring the ability of the athletes based on the technique. This research concludes that there are differences on knee angle joint that was formed on the ergometer and rowing on the catch phase, but there is no difference on leg velocity that is done in the next phase (drive). This is caused by the athlete's feet positions that differed when they were doing the stroke on the catch phase. Some athletes made maximum angle by bending their knees as high as possible, but some of them didn't bend their knees maximally. Whereas on the arm velocity (drive phase) between the ergometer and rowing, there is a difference. Next, a further research needs to be conducted, about the contribution of speed and segments for each body, as well as the activity of the dominant muscle using the electromiography.

REFERENCES

Anderson, R., Harrison, A., Lyons, G. M. 2007. Rowing Accelerometry-based Feedback - Can it Improve Movement Consistency and Performance in Rowing ?, (December 2014), 37–41.

Baudouin, A., Hawkins, D. 2002. A biomechanical review of factors affecting rowing performance, 396–402.

Baudouin, A., Hawkins, D. 2004. Investigation of biomechanical factors affecting rowing performance, 37, 969–976.

Bell, G., Bennett, J., Reynolds, W., Syrotuik, D., Gervais, P. 2013. A Physiological and Kinematic Comparison of two Different Lean Back Positions during Stationary Rowing on a Concept II Machine by, 37(June), 99–108.

Elliott, B., Lyttle, A., Birkett, O. 2007. Rowing The Row Perfect Ergometer : A Training Aid for On-Water Single Scull Rowing, (November 2014), 37–41.

Hofmijster, M. J., Landman, E. H. J., Smith, R. M., Soest, A. J. K. Van. 2007. Effect of stroke rate on the distribution of net mechanical power in rowing, (December 2014), 37–41.

Janshen, L., Mattes, K., Tidow, G. 2009. Muscular Coordination of the Lower Extremities of Oarsmen during Ergometer Rowing, (1991), 156–164.

Kinetics, H., Iii, S., Training, S. 2014. Prediction of Rowing Ergometer Performance from Functional Anaerobic Power, Strength, and Anthropometric Components, 41(June), 133–142.

Kleshnev, V. 2009. Boat acceleration, temporal structure of the stroke cycle, and effectiveness in rowing, 224, 63–74.

Lamb, D. H. 1989. Rowing. *The American Journal of Sports Medicine*, 3, 367–373.

Marcolin, G., Lentola, A., Paoli, A., Petrone, N. 2015. Rowing on a boat versus rowing on an ergo-meter : a biomechanical and electromyographical preliminary study. *Procedia Engineering*, 112, 461–466.

Mikuli, P., Smoljanovi, T., Bojani, I., Hannafin, J. A., Branka, R. 2000. Relationship between 2000-m rowing ergometer performance times and World Rowing Championships rankings in elite-standard rowers Relationship between 2000-m rowing ergometer performance times and, (October 2014), 37–41.

Nolte, V. 2011. *Rowing Faster, Training, Rigging, Technique, and Racing*. Human Kinetics Publisher, INC, Champaign, Illinois.

Whyte, S. A. I. Æ. G. P., Nevill, Æ. K. J. Æ. A. M. 2002. Determinants of 2, 000 m rowing ergometer performance in elite rowers, 243–244.