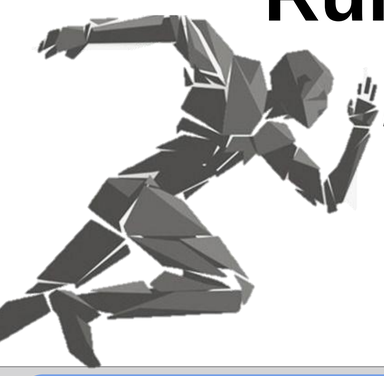
The Estimation of Running Economy and Motion Analysis of Runners Using Machine Learning on MotionMetrix Data



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RUN LAP RESEARCH CENTRE

BACKGROUND

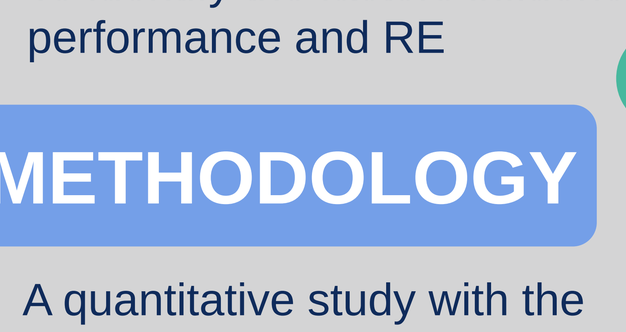
- For most athletes, achieving the shortest race time is their ultimate goal and one of the key determinants is running economy (RE)
- Running biomechanics such as the optimal stride length/frequency being ± 3% of preference range (Moore, 2016)
- MotionMetrix utilises advanced technologies to analyse data (Jaén-Carrillo et al., 2022)

PURPOSE

- To use MotionMetrix to analyse the running motion kinematics such as gait symmetry, and stride length
- To identify the factors influencing optimal running performance and RE

METHODOLOGY

- A quantitative study with the inclusion of machine learning to develop predictive models to predict running performance
- 59 participants (M:44, F:15), aged from 21-53 years old
- Racing experience in at least 10km
- No surgery within the last 12 months



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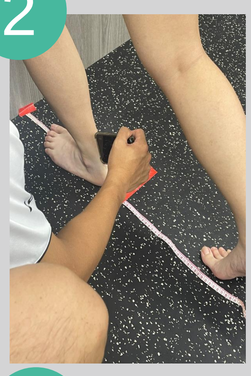

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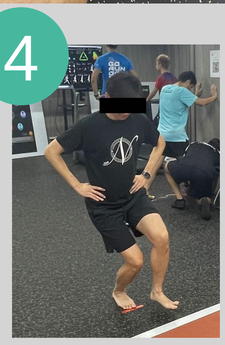

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Clinical Tests:

1. Foot Posture Index (FPI) - (Cowley & Marsden, 2013)
2. Weight-bearing Lunge (Ankle Dorsiflexion ROM) (Konor et al., 2012; Adillón et al., 2021)
3. Reactive Strength Index (RSI) (Markwick et al., 2015; Haynes et al., 2019)
4. Single-leg Squat (McGovern et al., 2019)
5. Hip Abduction Strength (Thorborg et al., 2010)

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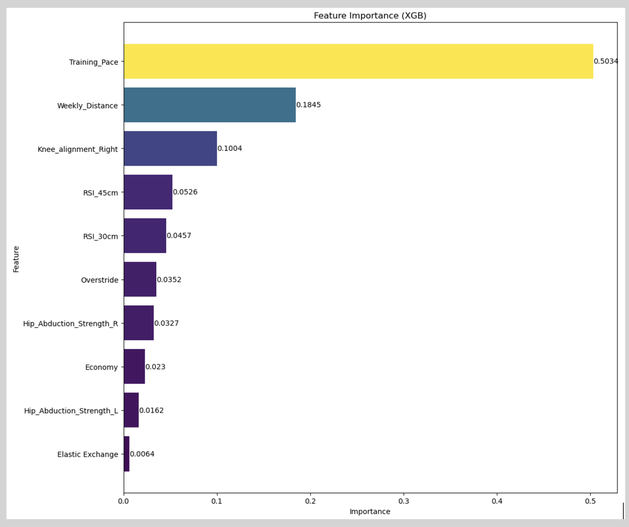
RESULTS

Model Performance Metrics			
	XGB	ANN	SVM
Cross-validated MAE	3.757	14.206	5.640
MAE	4.371	9.835	5.267
RMSE	5.484	13.322	6.756

***XGB most accurate**



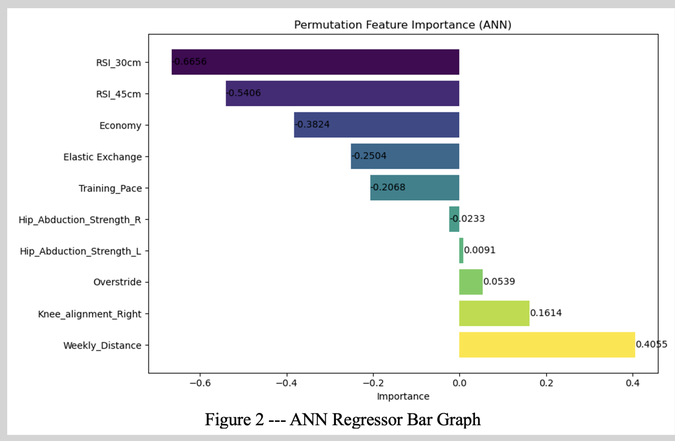


Figure 2 --- ANN Regressor Bar Graph

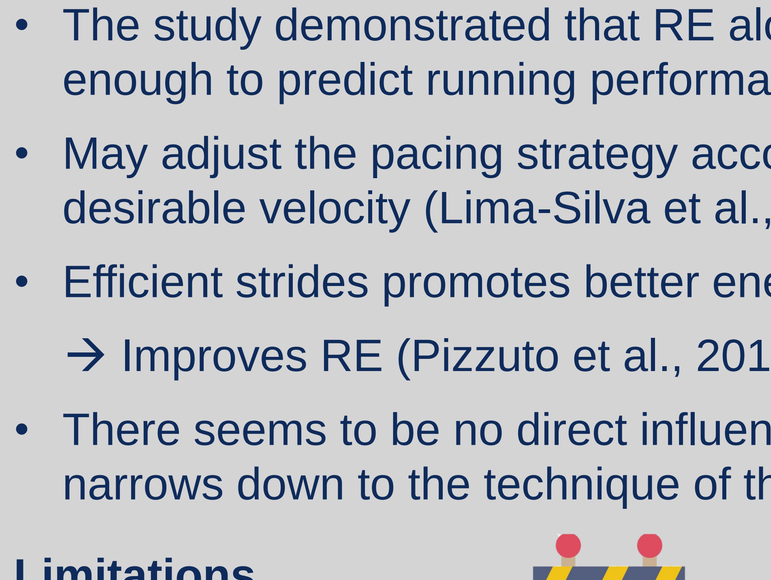


Figure 3 --- SVN Regressor Bar Graph

Hyper-parameters (XGB)

- **Learning rate (0.1)**
- **Maximum depth (7)**
- **No. Estimators (100)**

Feature Importance

- **Training Pace**
- **Weekly Distance**
- **Knee Alignment (R)**

***MAE within the 10% potential error range 4.931 minutes (<5 mins) for both genders**

DISCUSSION

- The study demonstrated that RE alone is not substantial enough to predict running performance
- May adjust the pacing strategy according to peak velocity and desirable velocity (Lima-Silva et al., 2009)
- Efficient strides promotes better energy transfer
  → Improves RE (Pizzuto et al., 2019; Moore, 2016)
- There seems to be no direct influence on RE, ultimately it all narrows down to the technique of the athletes

Limitations

- Small sample size
- Machine learning models learn better with bigger sample size (Training & Testing set)

PRACTICAL APPLICATION

- The selected features such as training pace can be retrained to improve RE
- Proper technique must not be neglected to promote RE