Active Drag of Elite Para-Swimmers During Front Crawl

Carl Payton, Yim-Taek Oh & Conor Osborough

Manchester Metropolitan University, UK

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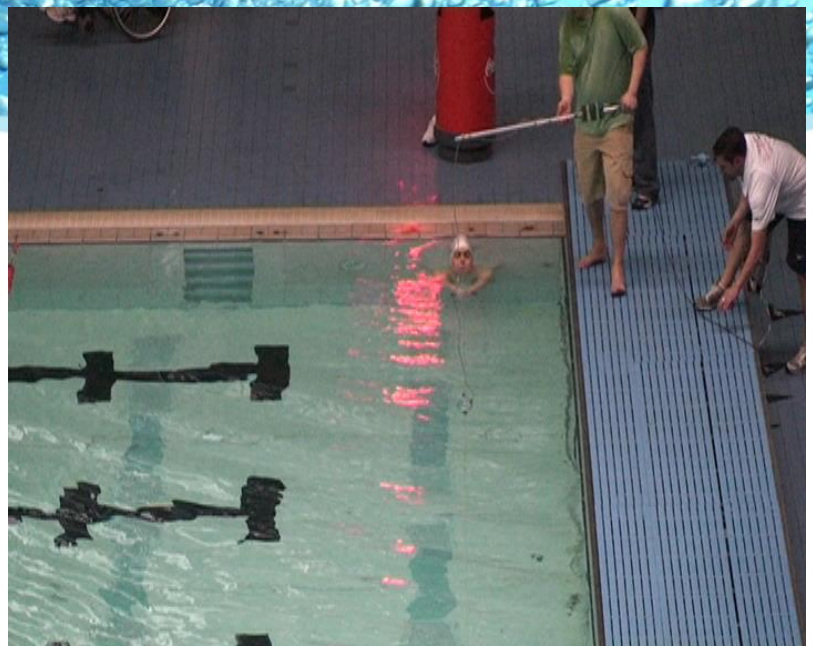
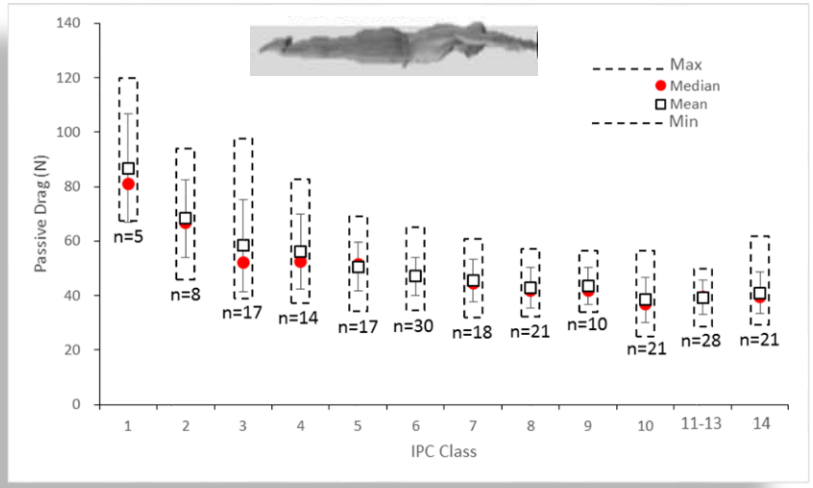
Introduction

- Drag is one of the key factors that limits swim performance (Toussaint *et al*., 2000).
- *Passive drag*: resistance encountered when moving through water holding a fixed position.
- Oh *et al*. (2013) reported a significant correlation between para-swimmers' passive drag and their IPC class.
- *Active drag*: resistance experienced when swimming.
- Able-bodied swimmers' active drag is highly influenced by their technique and skill level (Kolmogorov & Duplishcheva,1992).





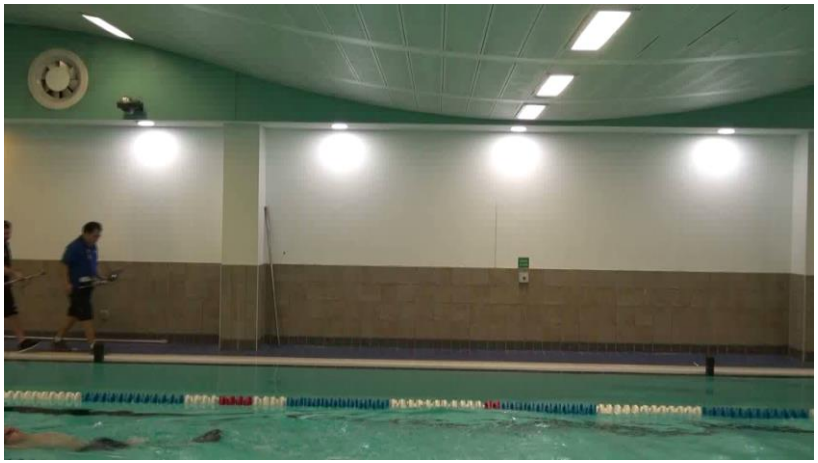
Oh Y-T *et al*. (2013). British Journal Sports Medicine, 47: 838–843.

Introduction

- A para-swimmer's impairment may restrict their technique and have a detrimental effect on active drag.
- No published studies on the active drag of para-swimmers.
- **PURPOSE**
  To establish the relationship between active drag, passive drag and IPC S class for elite para-swimmers performing front crawl.

Methods

- 16 elite para-swimmers (7♂, 9♀).
- 10 Gold, 2 Silver, 3 Bronze medallists at 2012 Paralympics or 2013 IPC Worlds.
- Classes S5 to S14.
- 21 ± 4 yrs 1.59 ± 0.19 m; 61.3 ± 9.7 kg.
- Active Drag (AD) during front crawl estimated by *Naval Architecture Based Approach* (Webb *et al*., 2011).
- **Stage 1:** Max front crawl speed found.
- **Stage 2:** Passive Drag with arms at sides measured at max speed (PD_{100}) and 110% max speed (PD_{110}).

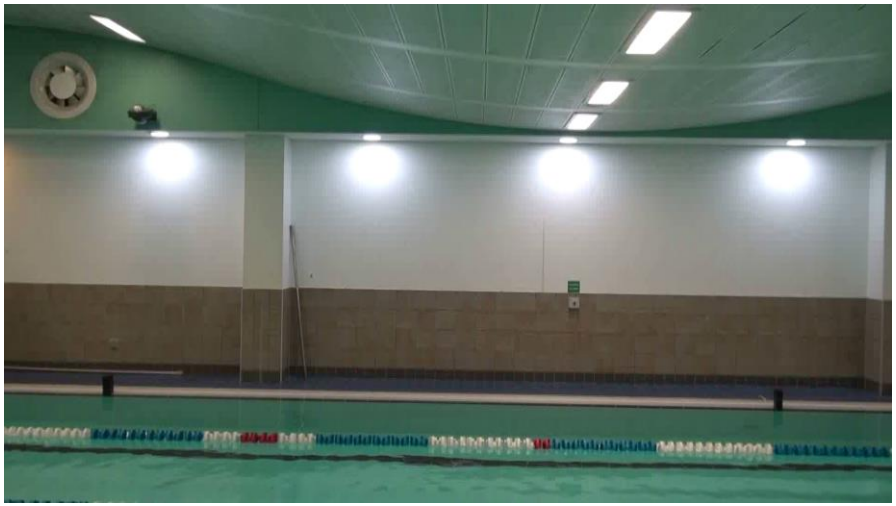


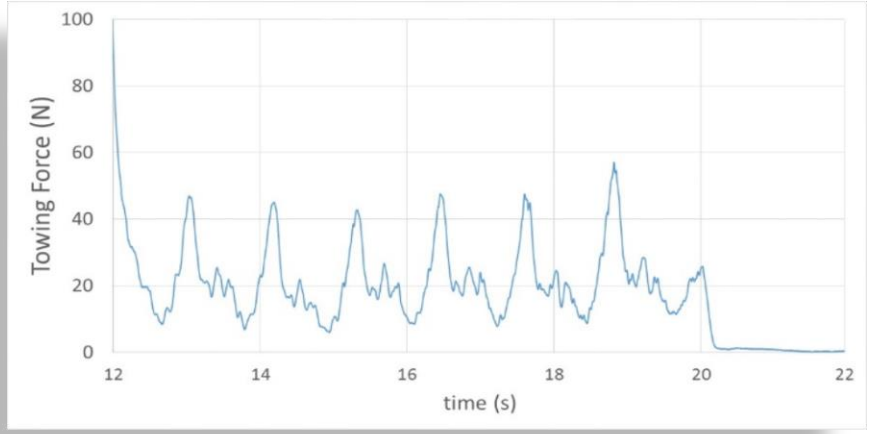
Methods

- **Stage 3:** Tow force (F_{TOW}) recorded at maximal effort front crawl while being towed at 110% speed.
- $AD = PD_{100} + F_{TOW} - (PD_{110} – PD_{100})$
- Lowest AD from three trials used in analysis.
- AD normalised for maximum speed (v_{100}) and body mass (BM)

$$AD_{NORM} = AD \cdot BM^{-1} \cdot v_{100}^{-2}.$$

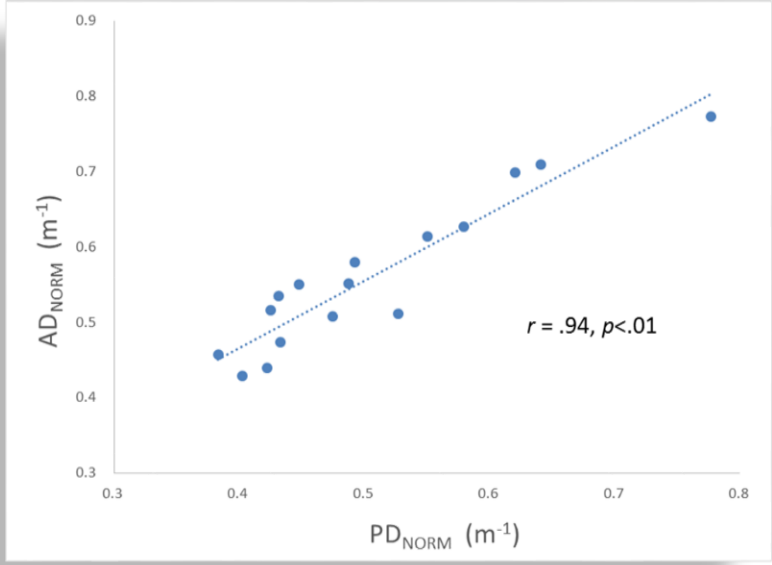
- PD was similarly normalised (PD_{NORM}).

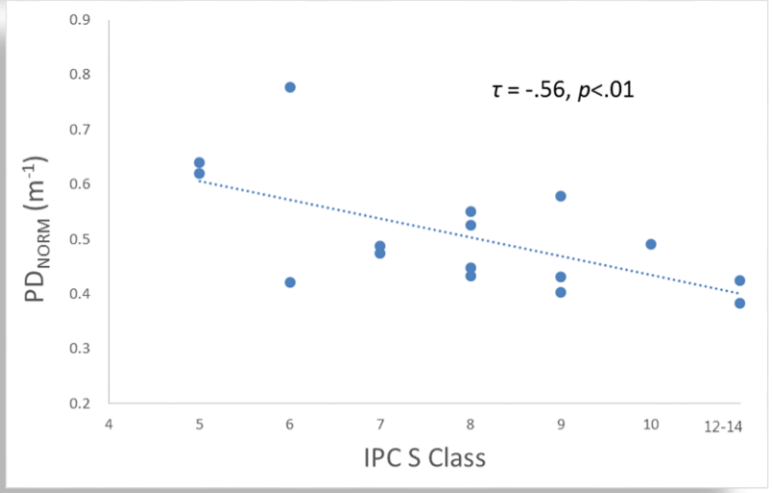




Results

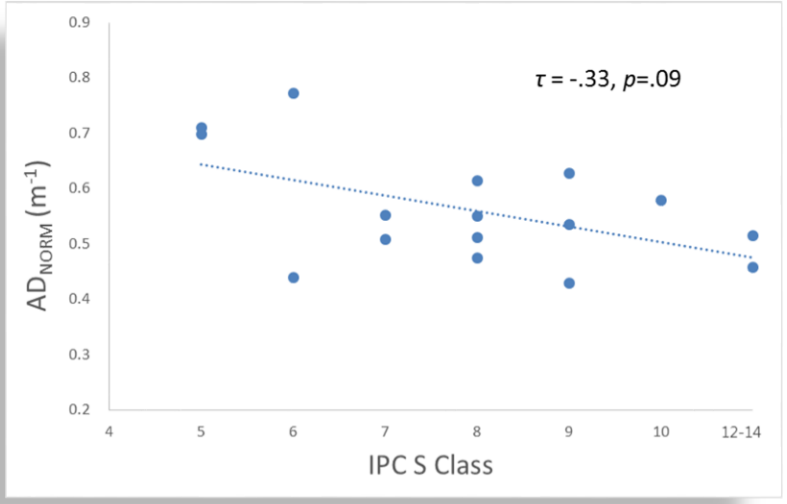
- Maximum front crawl speeds from 1.22 – 1.74 $m \cdot s^{-1}$.
- PD: 34.3-110.4 N; AD: 35.7-117.6 N.
- PD_{NORM} from 0.38 to 0.78 m^{-1} and AD_{NORM} from 0.43-0.77 m^{-1}.
- High positive association between PD_{NORM} and AD_{NORM} (r_p= .95, p<.01).
- Moderate negative association between PD_{NORM} and IPC S class (τ = - .56, p<.01).





Results

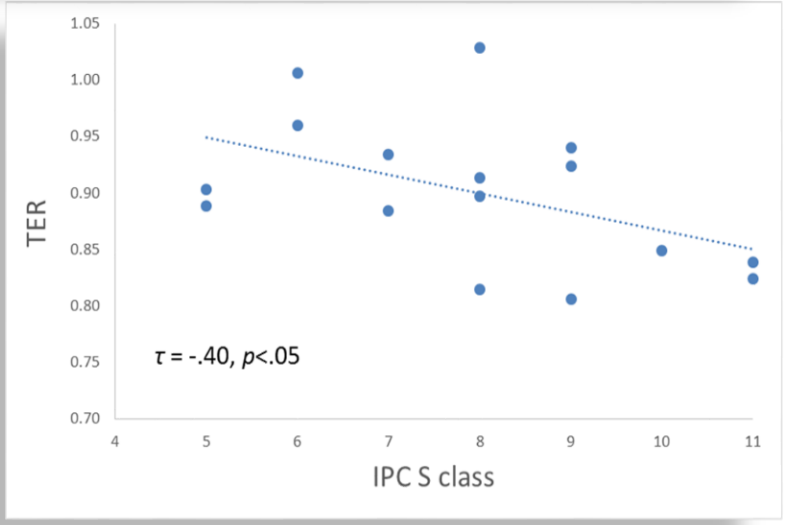
- Negative trend (ns) between AD_{NORM} and IPC S class (τ = - .33, p= .09).



Technical Effectiveness Ratio (TER)

TER = PD / AD

- TER range 0.81 – 1.03
- Moderate, negative association between IPC S class and TER (τ = -.40, p<.05)



Discussion

- Swimmers from lower IPC classes less able to achieve a streamlined position - supports previous findings (Oh *et al*., 2013).
- Clear trend for lower IPC class swimmers to create higher drag during front crawl.
- Three lowest class swimmers (S5-S6) created highest active drag. Athletes had considerable body asymmetry and three shortened limbs.
- S9 single arm amputee (at elbow) created the lowest active drag.
- S6 swimmer with good body symmetry and four functional limbs (achondroplasia) produced the second lowest active drag.

Discussion

- Technical Effectiveness Ratio (TER) showed most para-swimmers create more drag swimming than when gliding passively.
- Trend for the lower IPC class swimmers to have the higher (better) TER scores.
- Two double leg amps created less drag swimming than when being passively towed.
- TER can reflect ‘skill level’ in able-bodied swimmers (e.g. Kjendlie & Stallman, 2008).
- TER may show impact of specific impairments on technique in para-swimmers.
- A larger *n* and data from S1-S5 classes may strengthen all relationships found in study.

Conclusion

- Para-swimmers with relatively high passive drag were also those who had relatively high active drag during front crawl.
- Trend showing the lower IPC class swimmers creating higher active drag, but impairment type is more relevant when explaining differences in active drag.
- Technical Effectiveness Ratio may provide an insight into how a para-swimmer’s technique is influenced by their impairment.

Thank you for your attention

Acknowledgements

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References

Toussaint, H.M. (1990). Differences in propelling efficiency between competitive and triathlon swimmers. *Medicine and Science in Sports and Exercise*, 22, 409-415.

Kolmogorov, S. V. and Duplishceva, O. A. (1992). Active drag, useful mechanical power output and hydrodynamic force coefficient in different swimming strokes at maximal velocity. *Journal of Biomechanics,* 25, (3), 311 – 318.

Oh, Y-T., Burkett, B., Osborough, C., Formosa, D. &. Payton, C.J. (2013). London 2012 Paralympic swimming: passive drag and the classification system. *British Journal of Sports Medicine*, *47*, 1-6.

Kjendlie, P. & Stallman, R.K. (2008). Drag characteristics of competitive swimming children and adults. *Journal of Applied Biomechanics*, 24, 35-42.

Webb, A., Banks, J., Phillips, C., Hudson, D., Taunton, D. & Turnock, S. (2011). Prediction of passive and active drag in swimming. *Procedia Engineering*, 13, 133–140

Toussaint, H. M., Hollander, A. P., Berg, C. v. d., & Vorontsov, A. (2000). *Biomechanics of swimming*. In W. E. Garrett & D. T. Kirkendall (Eds.), Exercise and Sport Science (pp. 639-660). Philadelphia: Lippincott, Williams & Wilkins.