Active Drag of Elite Para-Swimmers During Front Crawl

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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).

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\textsubscript{100}) and 110% max speed (PD\textsubscript{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·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 (\(\tau = -.56, p<.01\)).
Results

- Negative trend (ns) between $A_{D_{\text{NORM}}}$ and IPC S class ($\tau = -.33, p = .09$).

**Technical Effectiveness Ratio (TER)**

$$\text{TER} = \frac{PD}{AD}$$

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

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