



Consideration of Passive Drag in IPC Swimming Classification System

Influence of Specific Impairments on Passive Drag

Yim-Taek Oh¹, Conor Osborough¹, Brendan Burkett², Carl Payton¹

¹Manchester Metropolitan University, UK

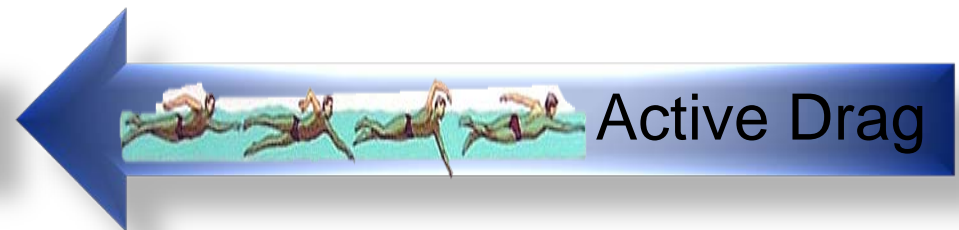
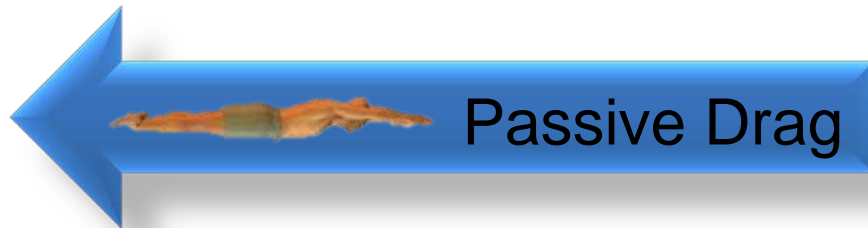
²University of the Sunshine Coast, Australia



October 7-10, 2015

Introduction

- Swimmer's speed $\uparrow \approx$ Propulsion \uparrow + Drag \downarrow
- A fair classification system should evaluate an individual's potential to achieve both of these things.
- In Human Swimming:



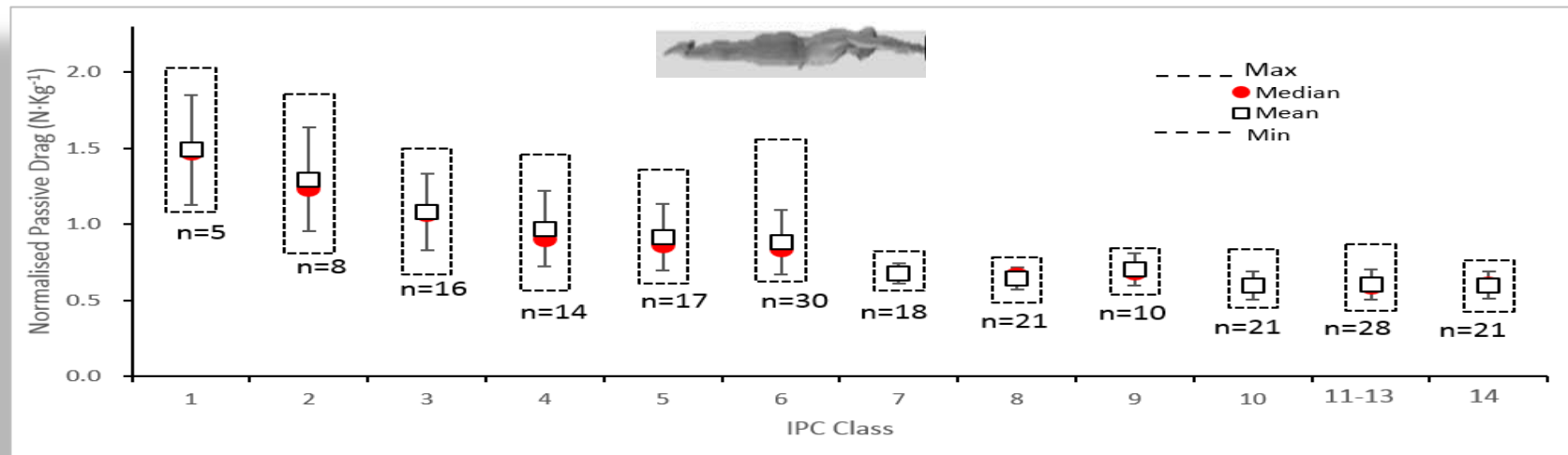
- In able-bodied swimming
Passive drag – highly dependent on anthropometry
Active drag – more dependent on technique

(Toussaint, 1990; Kolmogorov & Duplishcheva, 1992)

Previous Research

- Passive drag vs IPC Class

➤ Oh, Burkett, Osborough, Formosa & Payton (2013).



- Passive drag vs Anthropometry

- Oh (2015). N=185. Only 18% of the variability in Pd due to anthropometry.
- Para-swimmers with similar body dimensions can experience quite different passive drag. May be due to differences in the nature of their impairment.



Aims

- 1) Determine whether para-swimmers' passive drag changes in accordance with their impairment type.
- 2) Identify whether para-swimmers with certain impairments have an advantage or disadvantage, with respect to passive drag, under the current classification system.

Hypotheses

- 1) A para-swimmer's passive drag will be influenced by their impairment type.
- 2) Certain impairments can advantage or disadvantage a para-swimmer, with respect to drag, under the current classification system.

Methods

Data Collection

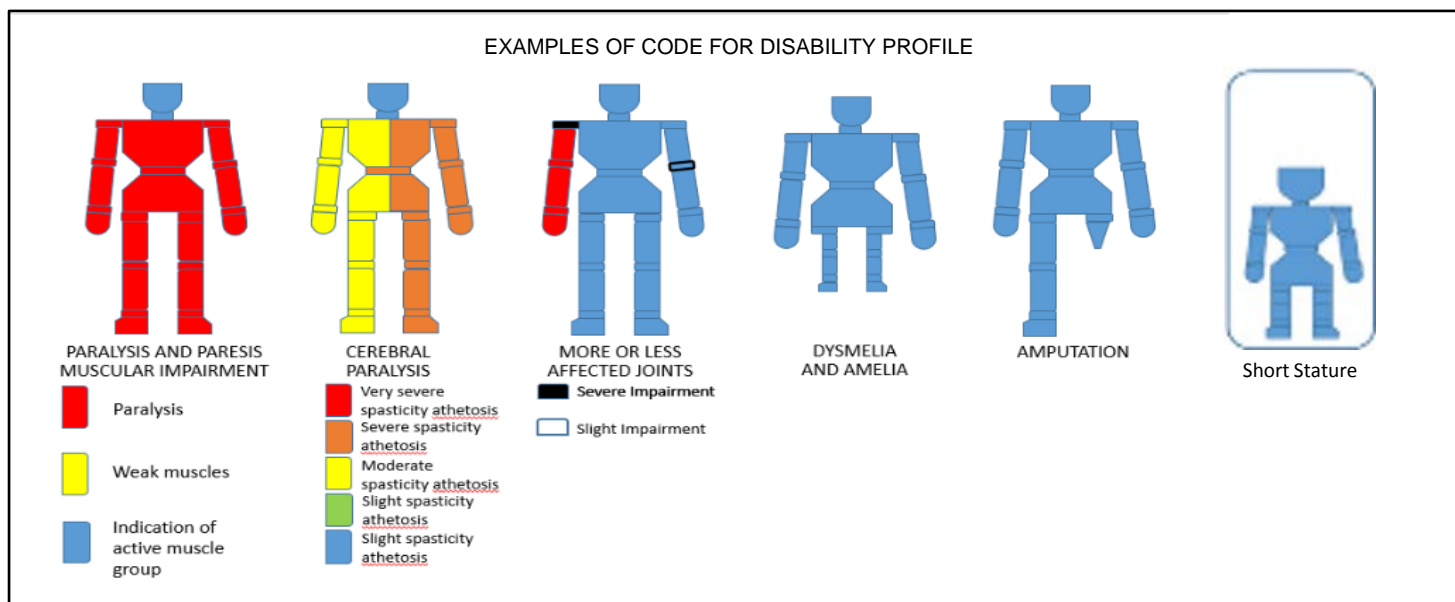
- 153 para-swimmers (93♂, 60♀).
97% competed in London Paralympics or World champs at Montreal or Glasgow.
- Classes 1 – 10.
- 25 ± 8 yrs, 1.60 ± 0.25 m, 60.7 ± 12 kg
- Towed on surface at $1.5 \text{ m} \cdot \text{s}^{-1}$ in their most streamlined position.
- Drag measured using an in-line load cell in a neutrally buoyant 'torpedo'.
- Force data sampled at 100 Hz.
- 3 – 7 trials conducted per swimmer.
- Swimmer's lowest drag force was normalised for body mass.



Methods

Impairment Groups

- 1) Spinal Cord Injury or Polio (SP1-8)
- 2) Cerebral Palsy (CP1-8)
- 3) Short Stature (SS1-2)
- 4) Les Autres (LA1-10)
- 5) Amputee or Dysmelia
 - Double-leg Amputee (DLA1-8)
 - Single-leg Amputee (SLA1-5)
 - Arm Amputee (AA1-5)

















Methods

Passive Drag Band (PDB 1-10)

- Swimmers were assigned to one of ten passive drag bands according to their normalised passive drag.
- Those with highest normalised passive drag were in PDB1.
- IPC Class integer compared to PDB integer.

Code for IPC Class vs PDB Differences

- Navy  : IPC Class  PDB by 3 or more.
- Blue  : IPC Class  PDB by 2.
- Green  : IPC Class  PDB by 1.
- Yellow  : IPC Class  PDB.
- Orange  : IPC Class  PDB by 1.
- Scarlet  : IPC Class  PDB by 2.
- Red  : IPC Class  PDB by 3 or more.

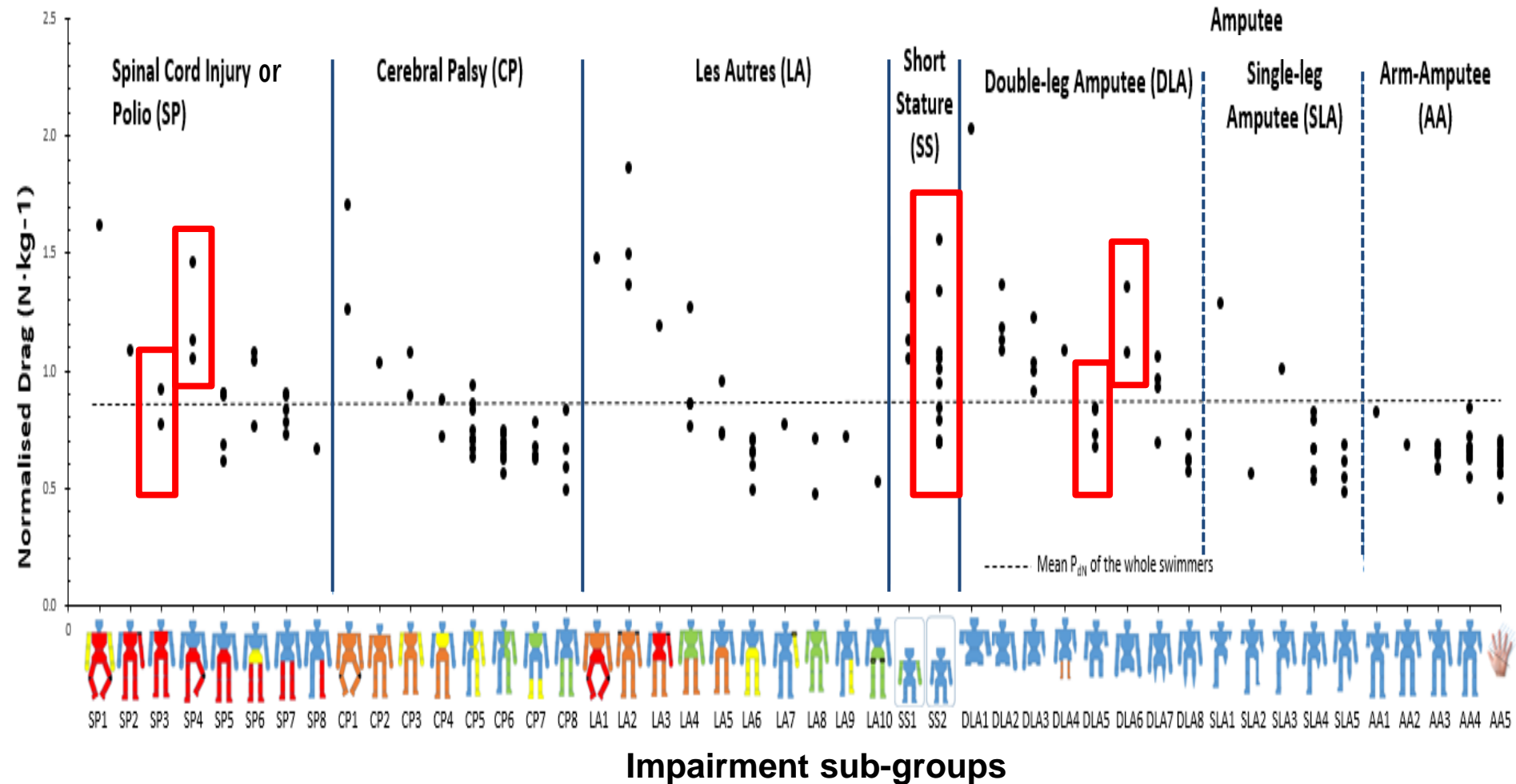


Swimmers who have smaller drag than others in the same IPC Class

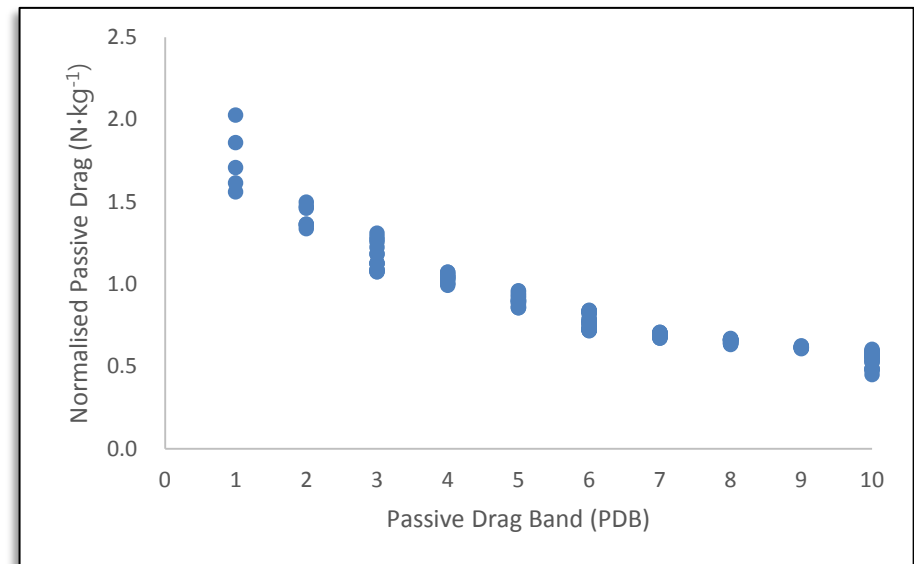
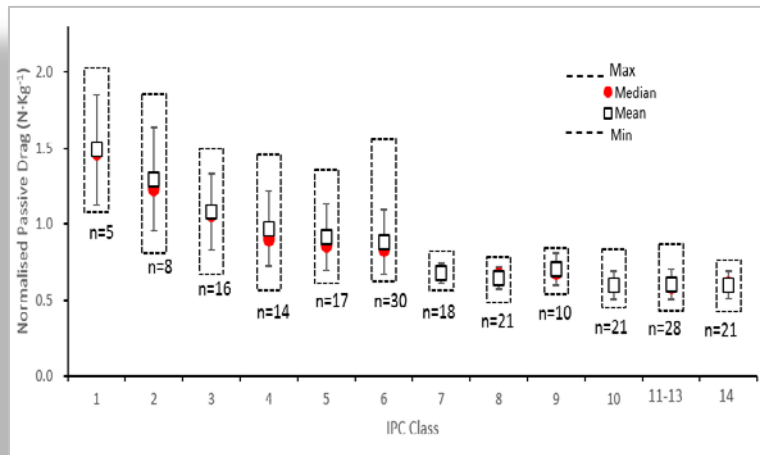


Swimmers who have greater drag than others in the same IPC Class

Results: Impairment sub-groups vs Passive drag



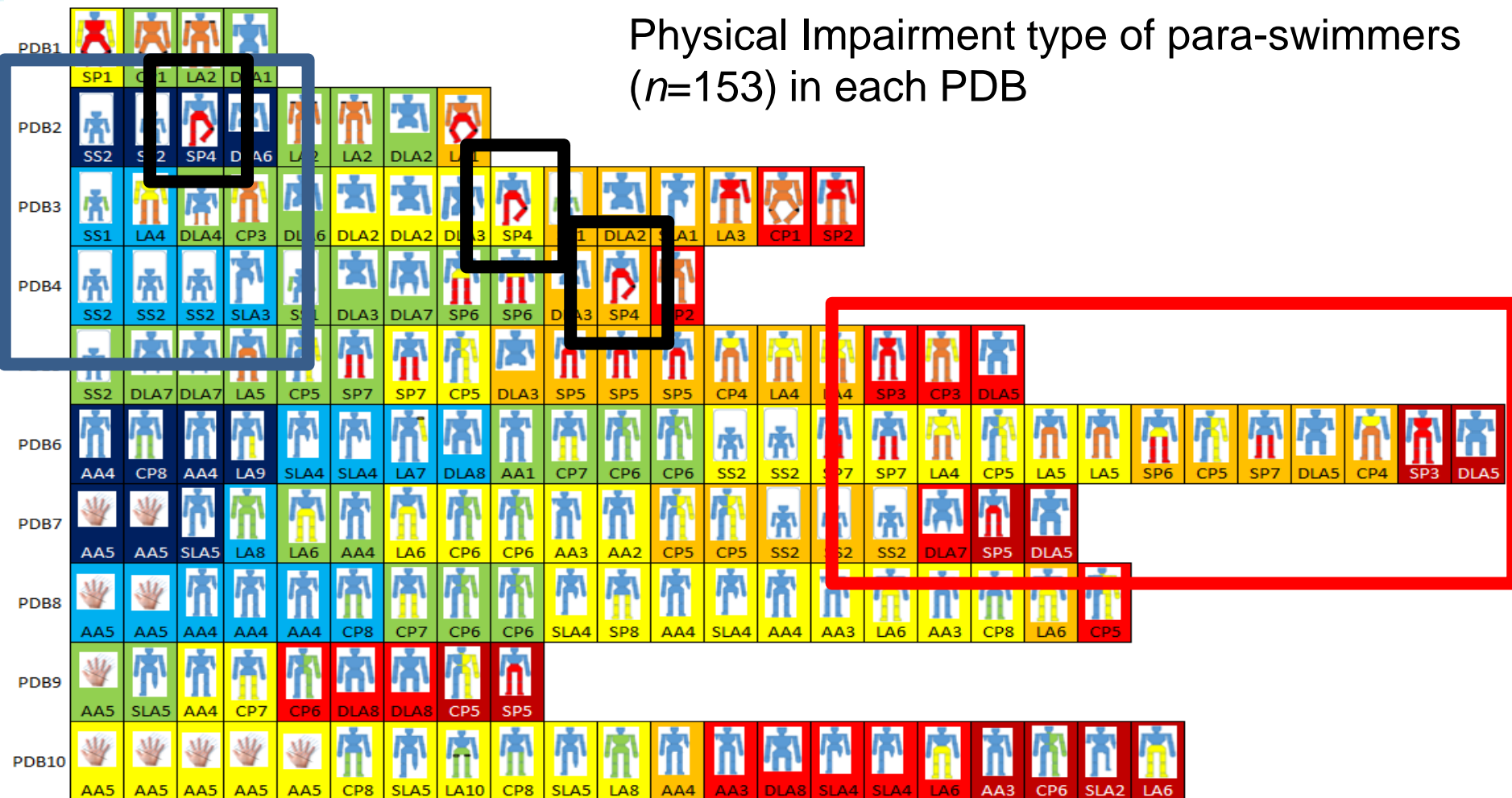
Results: Passive Drag Band (PDB)



PDB < IPC			IPC = PDB	PDB > IPC		
<-3	-2	-1		+1	+2	+>3
11 (7.2%)	17 (11.1%)	31 (20.3%)	42 (27.5%)	26 (17.0%)	16 (10.5%)	10 (6.5%)

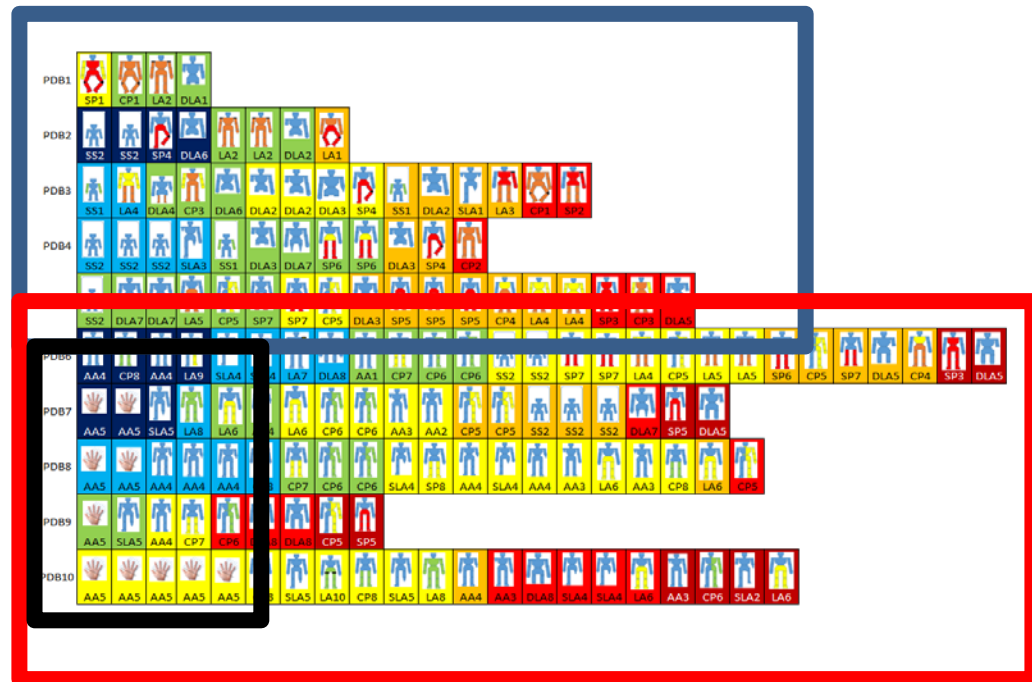
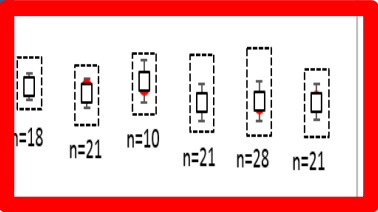
Results / Discussions

Physical Impairment type of para-swimmers
($n=153$) in each PDB





Discussions



Conclusions

- 1) A para-swimmer's passive drag is influenced by their impairment type.
- 2) Para-swimmers with Short Stature and para-swimmers with SCI with limited range of movement generally had higher drag than the other swimmers in the same class.
- 3) Para-swimmers with: i) 4 limbs amputated below knee/elbow and ii) severe SCI or CP but with no restriction at the shoulder, had relatively low drag compared to others in the same class.
- 4) Passive Drag Band may be a useful tool to help visualize which impairment types may advantage or disadvantage swimmer in terms of passive drag.



Thank you for your attention













Acknowledgements

British Para-Swimming....

References

- Kolmogorov, S.V., & Duplishcheva, O.A. (1992). Active drag, useful mechanical power output and hydrodynamic force coefficient indifferent swimming strokes at maximal velocity. *Journal of Biomechanics*, 25, 311-318.
- Oh, Y.-T., Burkett, B., Osborough, C., Formosa, D., & Payton, C. (2013). London 2012 Paralympic swimming: passive drag and the classification system. *British Journal of Sports Medicine* 47 (13), 838-843.
- Oh, Y.-T. (2015). *Passive and active drag of Paralympic swimmers*. PhD Thesis. Manchester Metropolitan University, UK.
- Toussaint, H. M. (1990). Differences in propelling efficiency between competitive and triathlon swimmers. *Medicine and Science in Sports and Exercises*, 22, 409-415.

Results: IPC Class vs PDB differences

IPC Class 1	 SP1	 LA1	 CP1	 SP2																							
IPC Class 2	 DLA1	 LA2	 CP1	 SS1	 SLA1	 LA3	 DLA2	 CP2																			
IPC Class 3	 LA2	 DLA2	 LA2	 DLA3	 DLA2	 SP4	 DLA2	 SP4	 DLA3	 SP3	 CP3	 DLA5	 DLA5	 SP3	 DLA5												
IPC Class 4	 CP3	 DLA4	 DLA6	 SP5	 SP5	 DLA3	 SP5	 LA4	 LA4	 CP4	 SP5	 SLA2															
IPC Class 5	 DLA6	 SP4	 SS1	 LA4	 DLA3	 SP6	 DLA7	 SS1	 SP6	 CP5	 SP7	 CP4	 SP6	 DLA5	 CP5	 SP7	 DLA7	 SP5									
IPC Class 6	 SS2	 SS2	 SS2	 SS2	 SS2	 SLA3	 SS2	 DLA7	 DLA7	 SP7	 CP5	 LA5	 SS2	 SS2	 SP7	 SP7	 LA5	 LA4	 CP5	 LA5	 SS2	 SS2	 SS2	 CP5	 CP5	 CP5	 CP5
IPC Class 7	 CP6	 CP6	 CP7	 AA1	 AA2	 AA3	 CP6	 CP6	 LA6	 CP6	 CP6	 CP7	 LA6	 CP6	 DLA8	 DLA8	 CP6	 AA3	 LA6								
IPC Class 8	 LA7	 DLA8	 SLA4	 SLA4	 LA6	 AA4	 CP7	 LA6	 AA3	 AA3	 AA4	 AA4	 SLA4	 SLA4	 SP8	 AA3	 DLA8	 LA6	 SLA4	 SLA4							
IPC Class 9	 AA4	 AA4	 LA8	 AA4	 AA4	 AA4	 AA4	 AA4	 CP7	 AA4																	
IPC Class 10	 AA5	 AA5	 SLA5	 CP8	 LA9	 AA5	 AA5	 CP8	 SLA5	 AA5	 AA5	 AA5	 AA5	 AA5	 AA5	 SLA5	 SLA5	 LA8	 CP8	 CP8	 LA10						