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# Relationship between Anthropometry and Passive Drag of Physically Impaired Swimmers

Yim-Taek Oh<sup>1</sup>, Conor Osborough<sup>1</sup>, Brendan Burkett<sup>2</sup>, Carl Payton<sup>1</sup>

<sup>1</sup>Manchester Metropolitan University, UK

<sup>2</sup>University of the Sunshine Coast, Australia



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## *Drag*

- Resistance force which acts on a swimmer in the opposite direction to swimming.
- In Human Swimming



- Active drag - more dependent on technique  
Passive drag - more dependent on anthropometry







Kolmogorov and Duplishcheva, 1992

- Influenced by speed, depth, shape, posture, size, and the frontal surface area.

Kjendle & Stallman, 2008

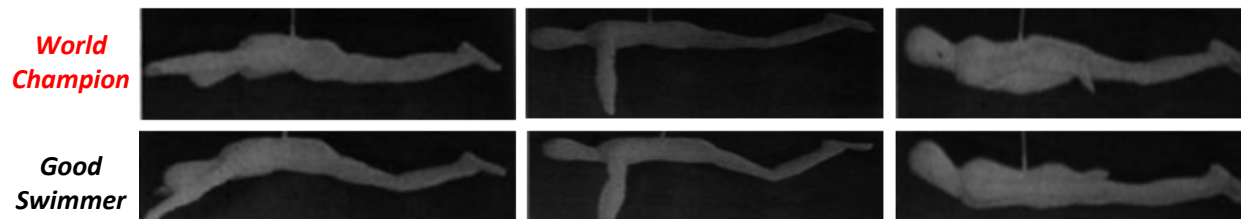
# PREVIOUS RESEARCH

## Factors Affecting Drag

- Speed  Drag   
Karpovich ,1933; Counsilman, 1955.
- Depth  Drag   
Vennell *et al.*, 2006; Novais *et al.*, 2012.
- Technique  Drag   
Clarys *et al.*, 1974
- Body Position



Kent & Atha, 1971



Taiar *et al.*, 1999

### *Factors Affecting Drag*

- **Size and Shape**



-Height ?

Yes – Huijing *et al.*, 1988

No – Miyashita and Tsunoda, 1978

-Cross Sectional Area? Yes - Benjanuvatra *et al.*, 2001

No – Toussaint *et al.*, 1990

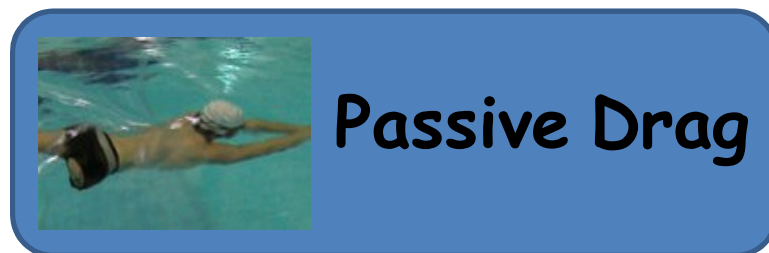
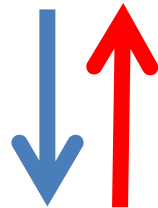
- **Physical Impairment**

Level of Physical Impairment vs Drag - Chatard *et al.*, 1992

Paralysis > Multiple dysmelia > Single leg-amputee – Karger, 2012

**No published study on anthropometry of high level swimmers with a disability**

To examine the relationship between:  
1) the anthropometry and IPC Class, and 2) passive drag and the anthropometry, of highly trained disability swimmers



## Hypotheses

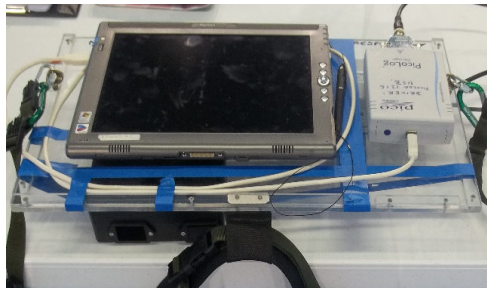
1. There will be a positive relationship between IPC Class and anthropometric measures.
2. There will be a significant relationship between anthropometric measures and passive drag.

## ***Anthropometry***

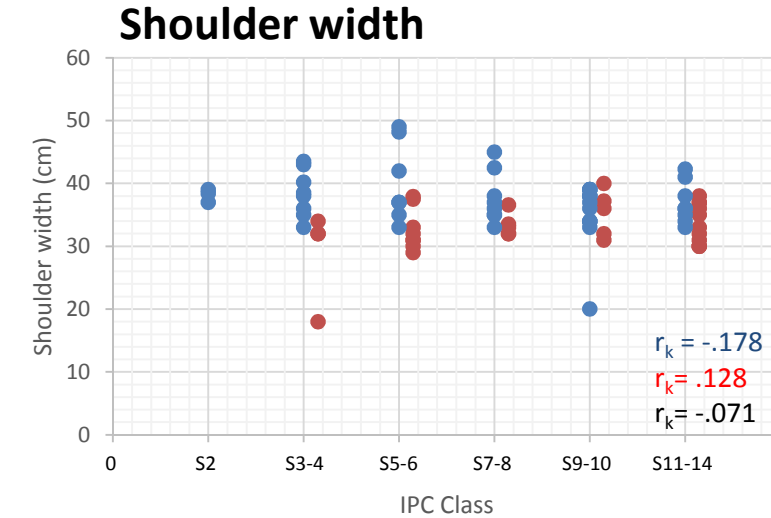
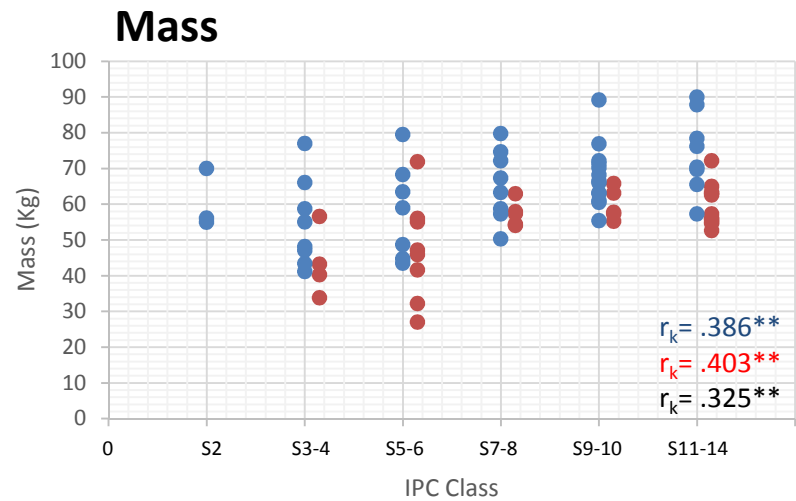
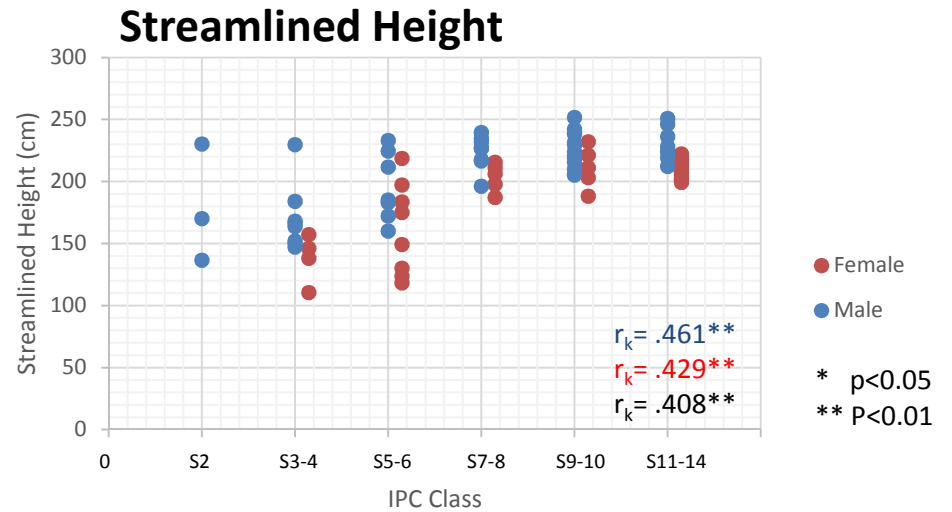
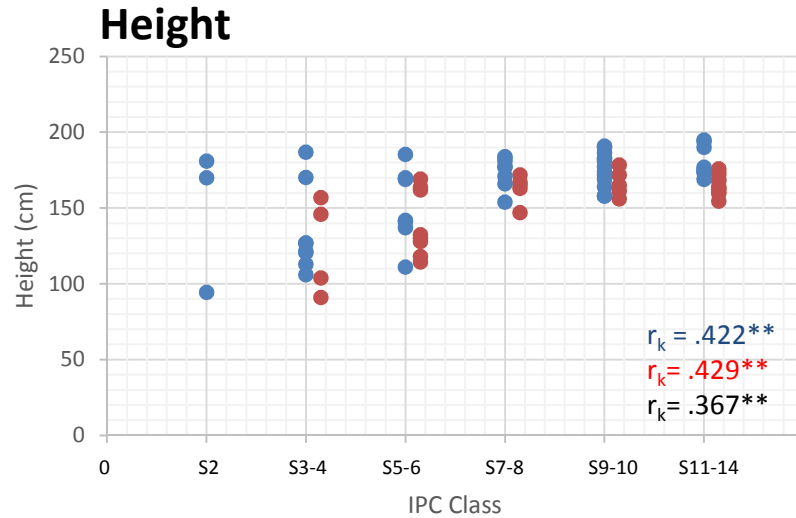
- 80 Swimmers (Height  $1.59.8 \pm 0.25$  m; Mass  $60.3 \pm 12.5$  kg) (47 Males, 33 Females; 98% competed in London 2012 Paralympic Games)
- Streamlined Height, Height, Mass, Shoulder Width, Chest Depth, Shoulder Girth, Streamlined Shoulder Girth.

## ***Passive Drag***

- Towing Speed:  $1.5 \text{ m} \cdot \text{s}^{-1}$  (Electromechanical towing device)
- Drag force measured using load-cell
- Statistics: Kendall's tau<sub>b</sub> (IPC Class vs Drag) & Pearson Correlation (Anthro vs Drag)

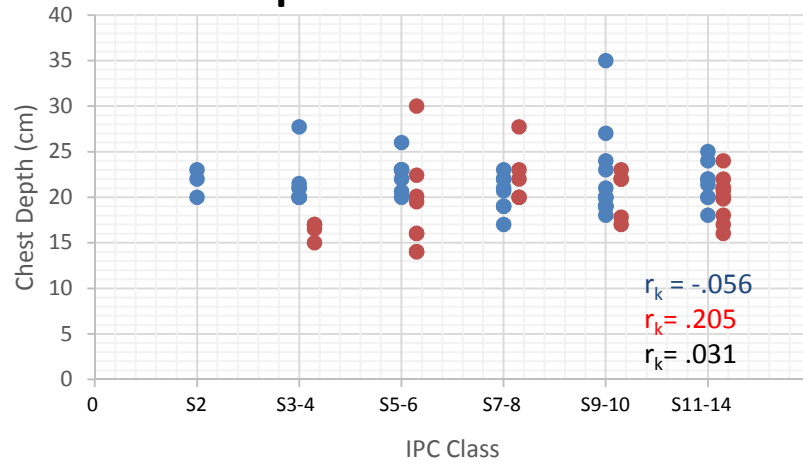


## IPC Class vs Anthropometry

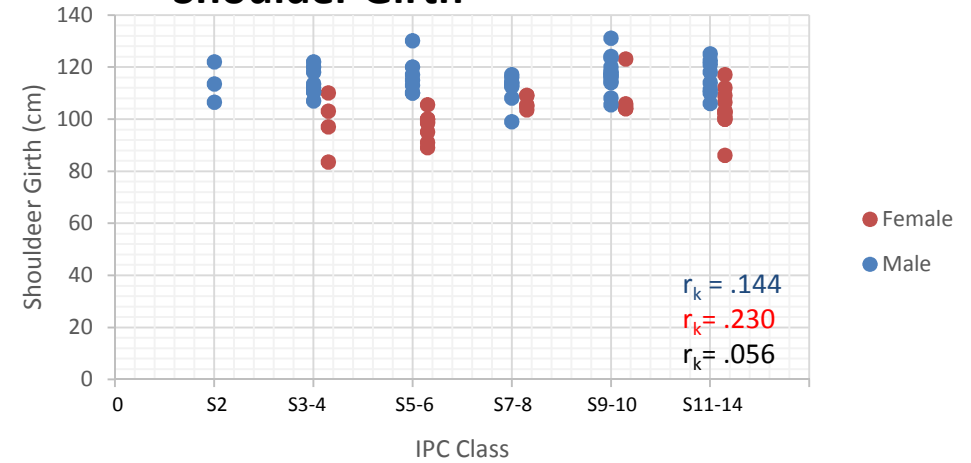


## IPC Class vs Anthropometry

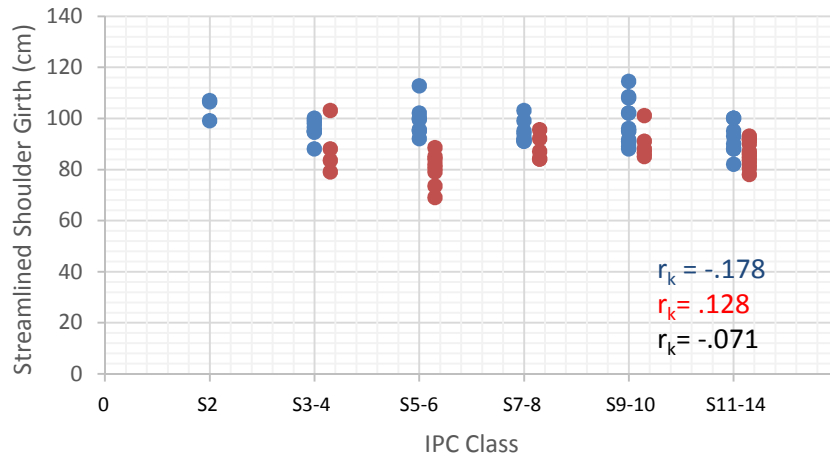
### Chest Depth



### Shoulder Girth

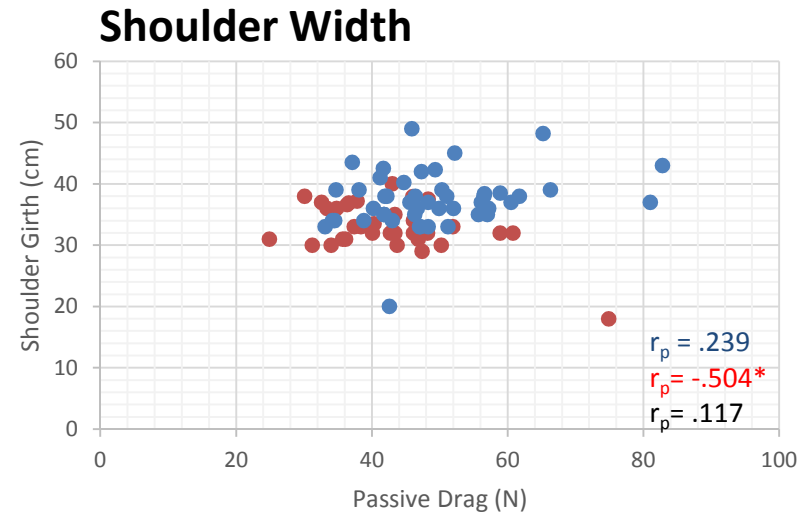
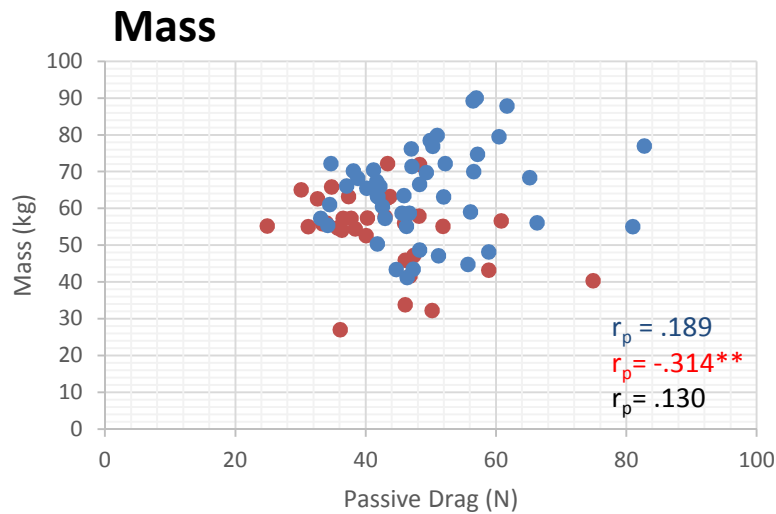
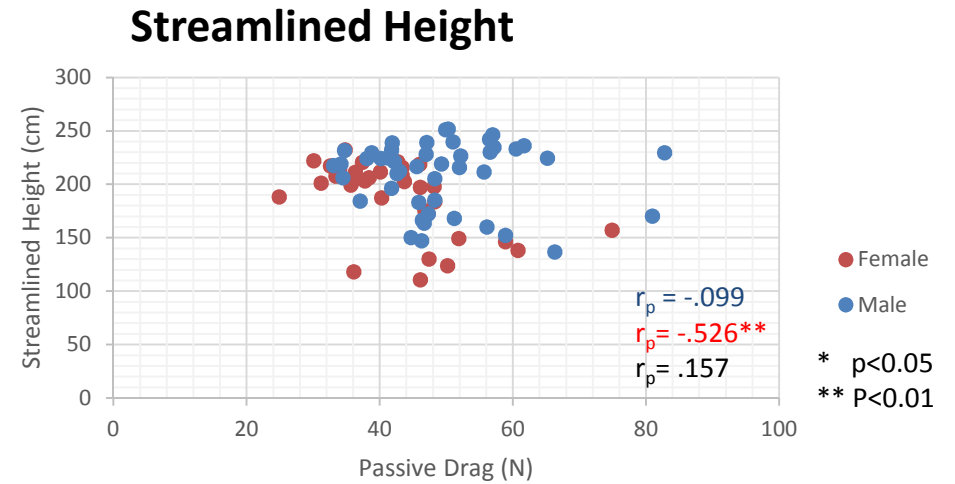
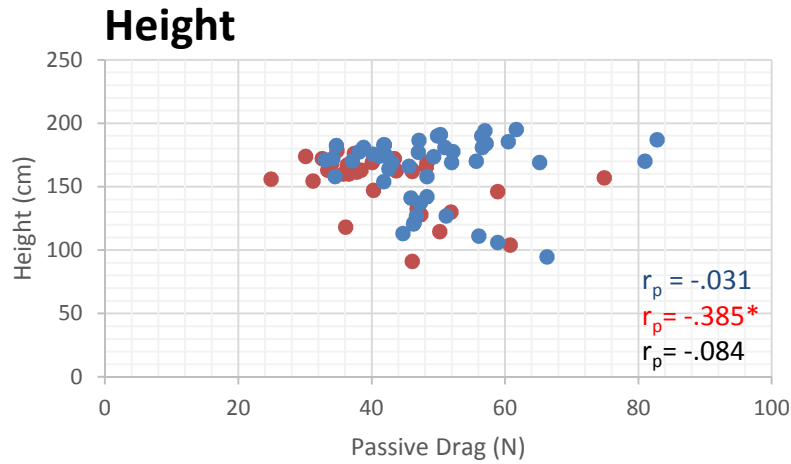


### Streamlined Shoulder Girth

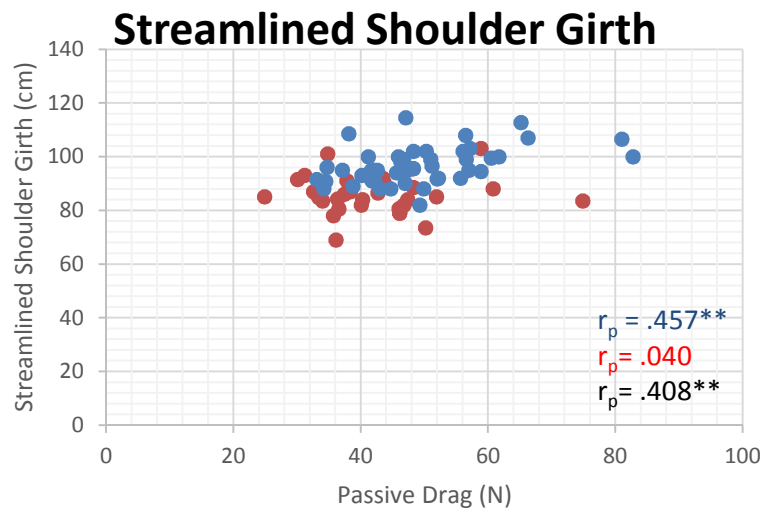
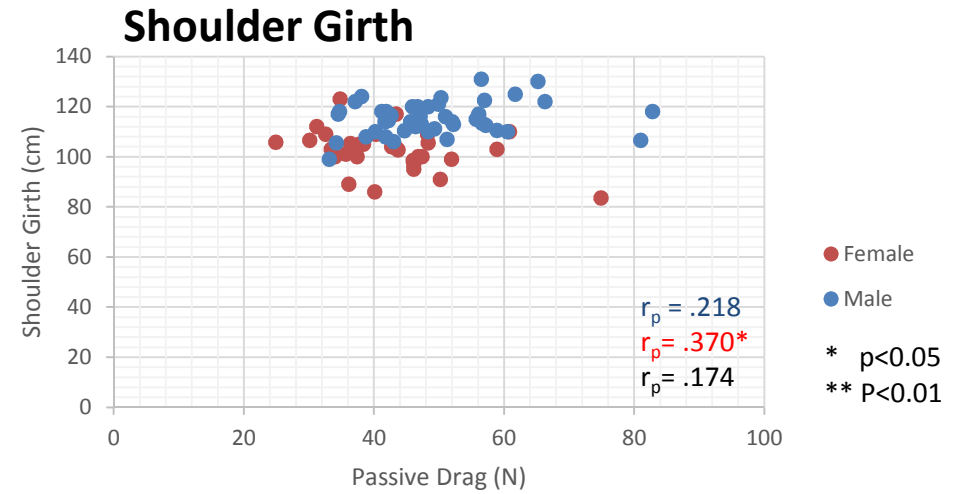
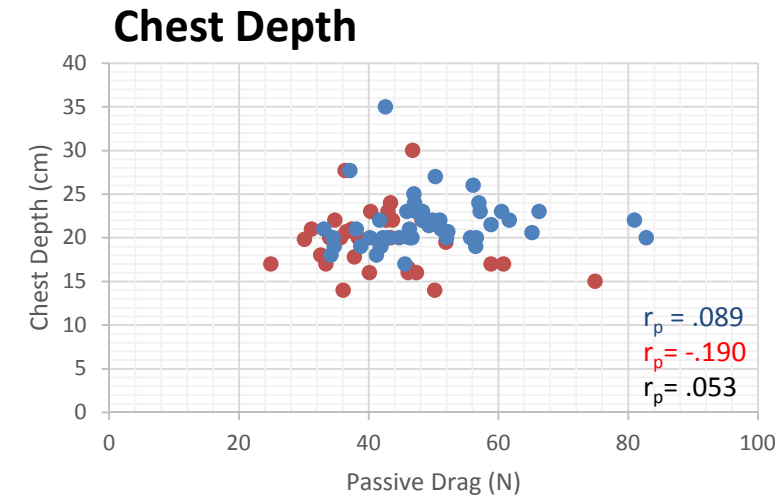


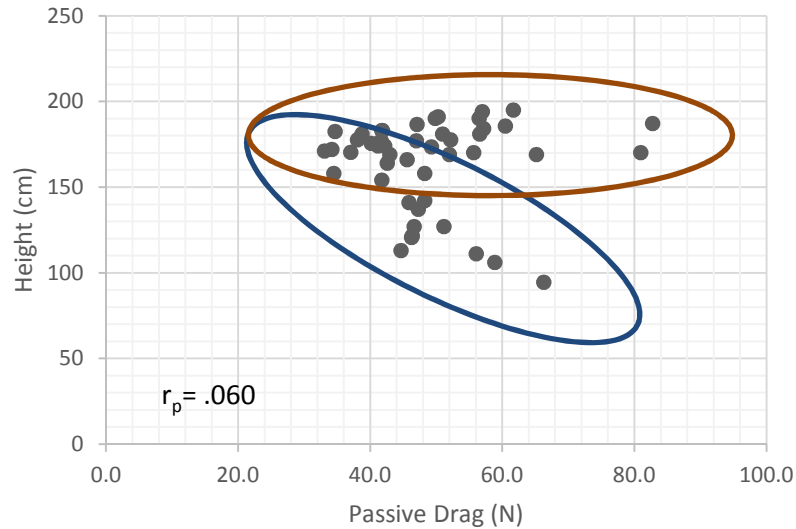


## Passive Drag vs Anthropometry



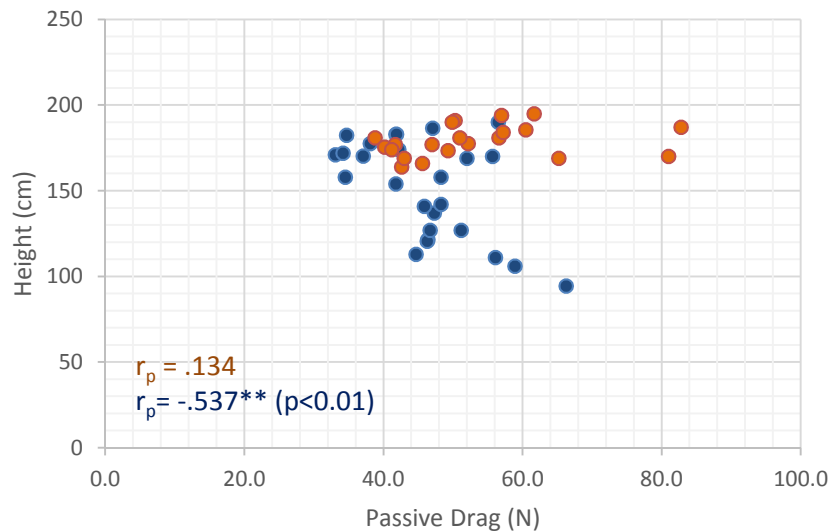
## Passive Drag vs Anthropometry





➤ Size Specific Impairment (SI)  
– Amputee, Dysmelia, Dwarf, etc.

➤ Functional Specific Impairment (FI)  
– Cerebral Palsy, Poliomyelitis, etc.



## CONCLUSION

- Height, Streamlined Height, Mass showed a moderate positive relationship with IPC Class but Shoulder Width, Chest Depth, Shoulder Girth, Streamlined Shoulder Girth did not.
- There was no meaningful relationship between any anthropometric measures and passive drag.

## ACKNOWLEDGEMENTS



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