

Relationship between Passive Drag and Performance Time of Paralympic Swimmers

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Introduction

Classification System in Swimming (IPC)



- *S1 is the most impaired and S10 is the least impaired*
- NOT dependent on **type** of disability but on **severity** of disability

S11-13



S14: Intellectual Impairment

Categories

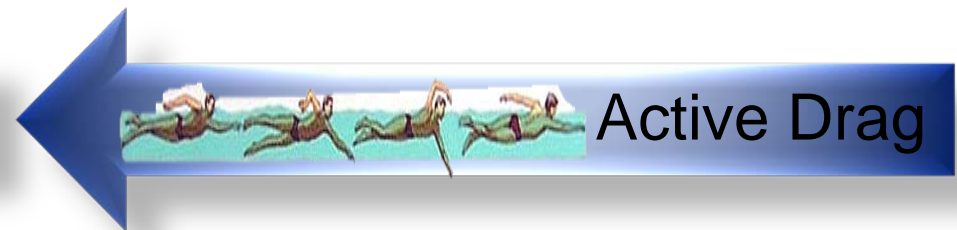
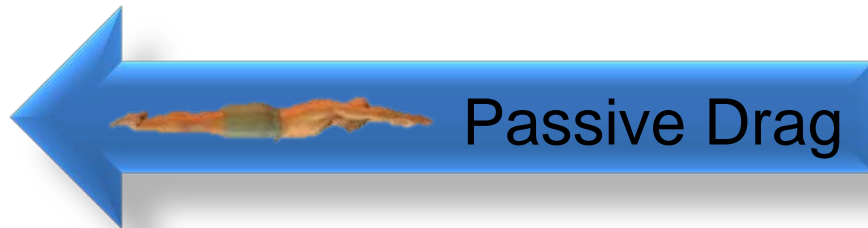
S: classification for Freestyle, Backstroke and Butterfly

SB: classification for Breaststroke

SM: classification for Individual Medley ($\frac{3S + 1SB}{4}$)

Introduction

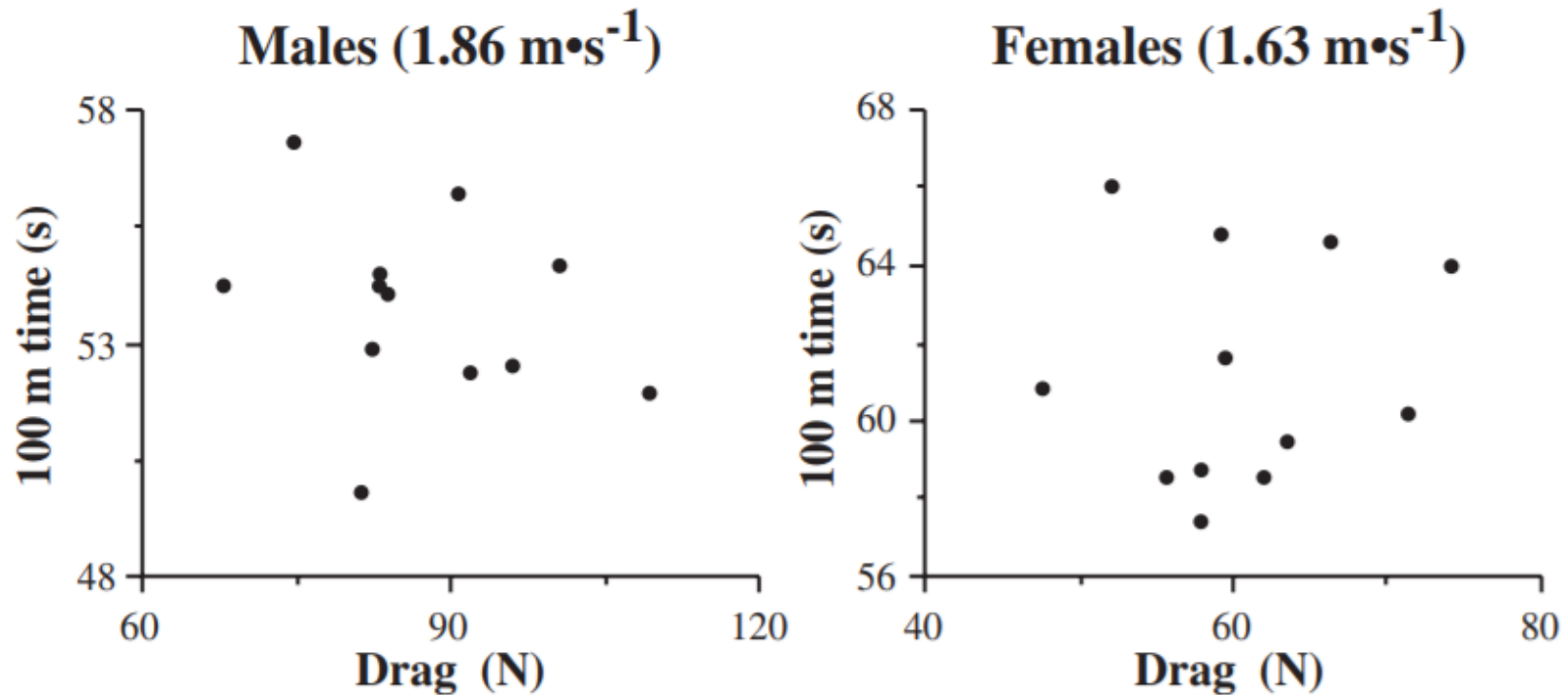
- Swimmer's speed $\uparrow \approx$ Propulsion \uparrow + Drag \downarrow
- A fair classification system should evaluate an individual's potential to achieve both of these things.
- In Human Swimming:



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

(Toussaint, 1990; Kolmogorov & Duplishcheva, 1992)

Introduction



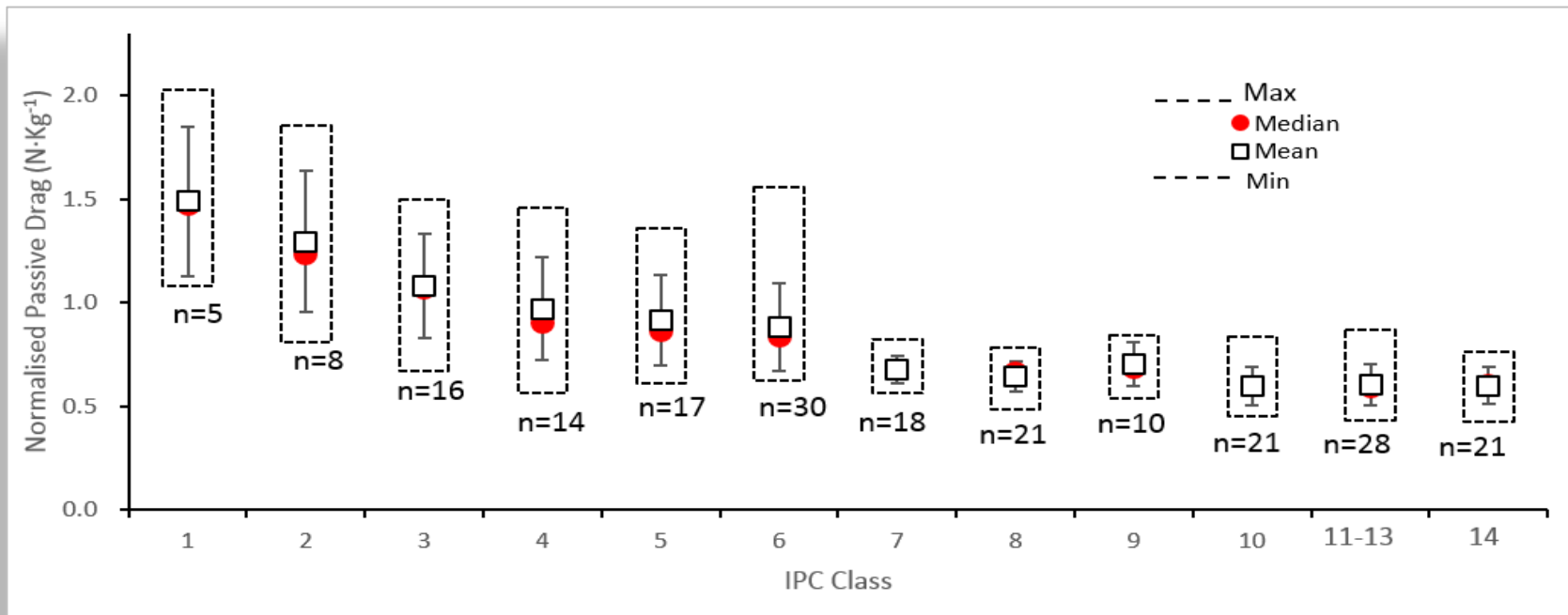
Front Crawl performance time versus drag measured at a fixed speed

(Toussaint *et al.*, 2000)

Previous Research

- **Passive drag vs IPC Class**

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



Passive Drag vs Performance Time?



Aim

- Determine the relationship between front crawl performance time (PT) and passive drag (PD) of swimmers with physical impairments.

Hypothesis

- Athletes with faster performance time will exhibit lower passive drag, and *vice versa*.

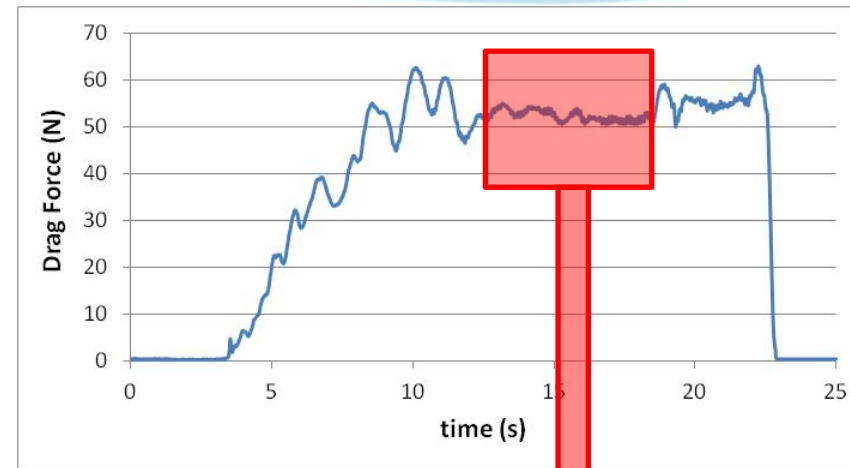
Methods: data collection

- 140 swimmers (87♂, 53♀). London 2012 Paralympics or Montreal 2013 WC.
- Classes S1 – S10 (23 ± 6 yrs, 1.66 ± 0.07 m, 60.3 ± 6.2 kg).
- Towed on surface at $1.5 \text{ m}\cdot\text{s}^{-1}$ (3-7 trials).
- Drag measured (100 Hz) using an in-line load cell.
- 50-m & 100-m Freestyle PT obtained from IPC database (SDMS).



Methods: data analysis

- Mean force calculated when curve reached plateau.
- Lowest drag force from swimmer's trials was analysed.
- Pearson Correlation.
(No < 0.3; 0.3 < weak < 0.5;
0.5 < moderate < 0.7; > 0.7 strong)



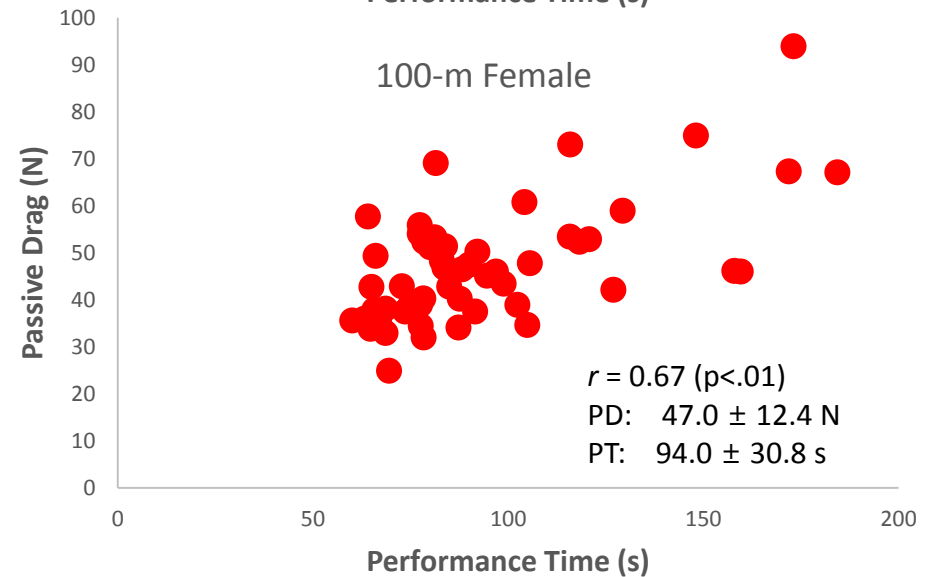
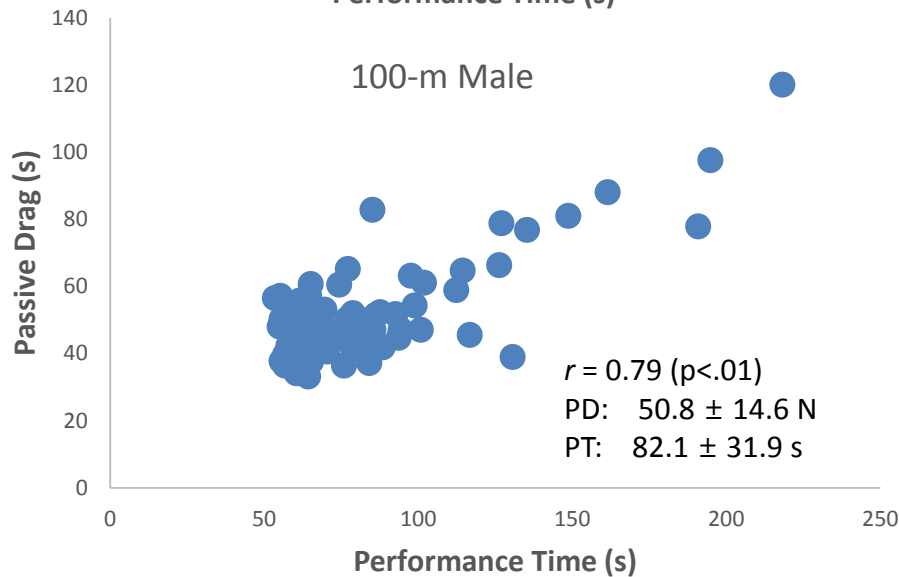
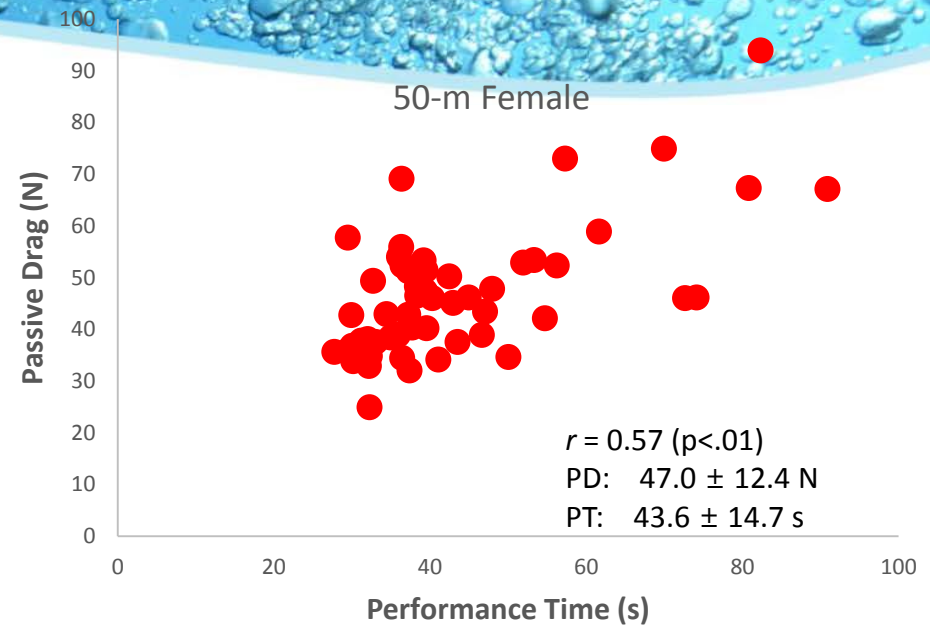
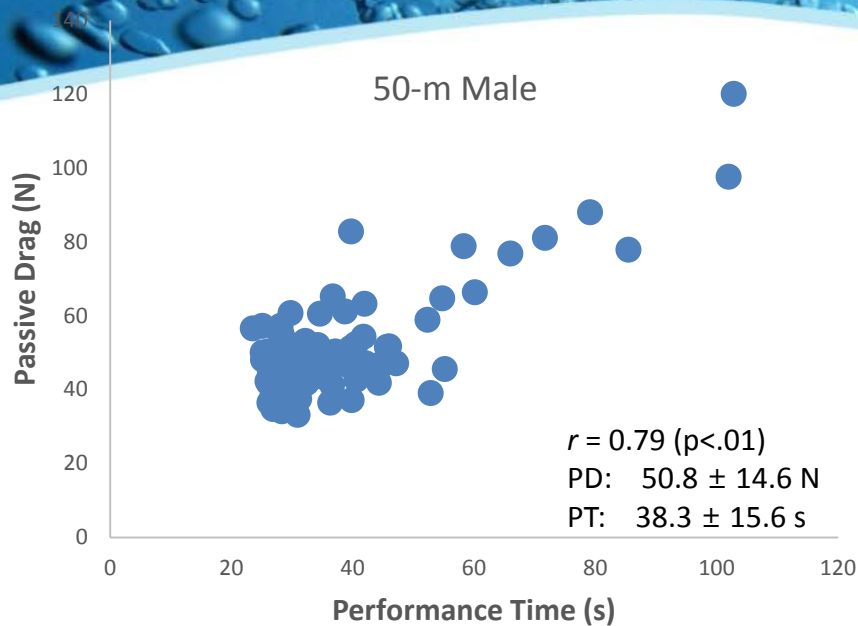
Average Drag = 53.2 N

Number of participants in each class

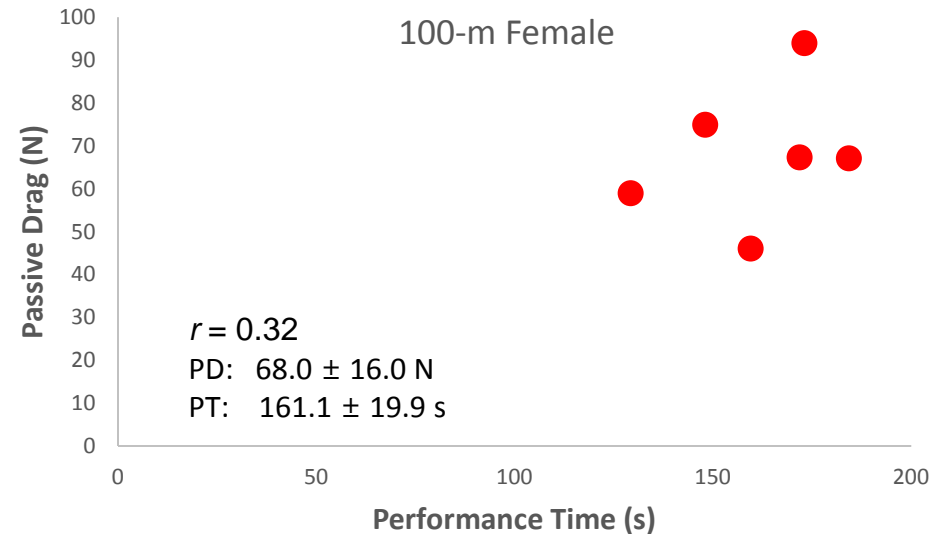
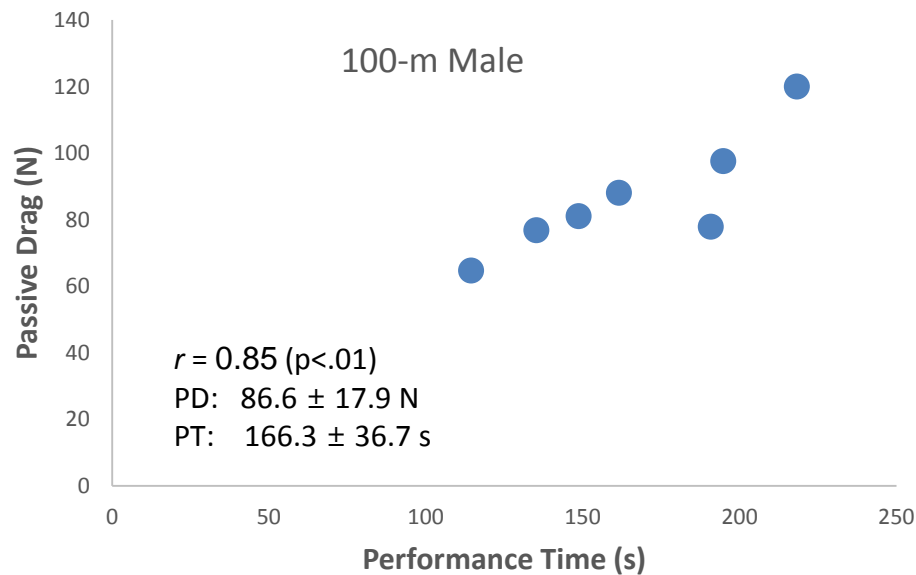
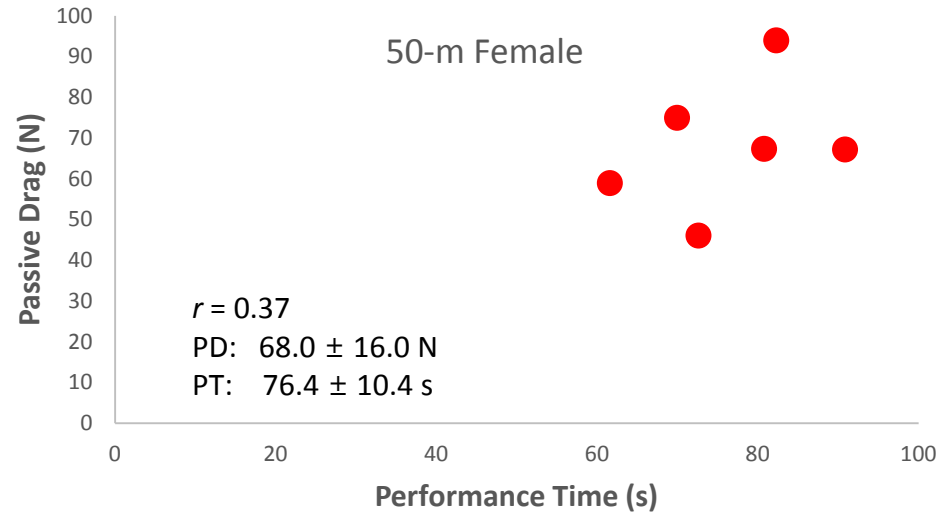
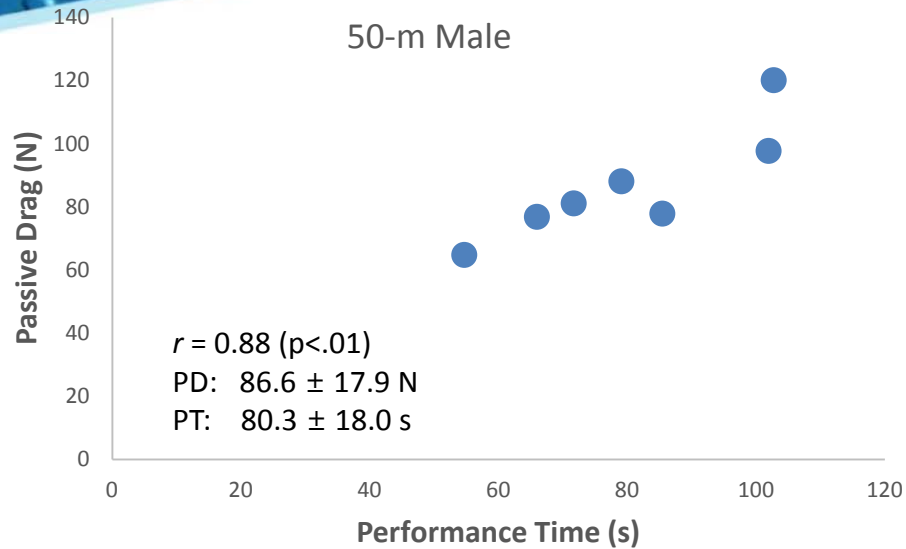
Class	1	2	3	4	5	6	7	8	9	10	Total
N	1	3	3	6	12	12	12	13	13	12	87
N	7			18		12	12	13	13	12	87

Class	2	3	4	5	6	7	8	9	10	Total
N	1	5	3	6	12	9	4	6	7	53
N	6		9		12	9	10		7	53

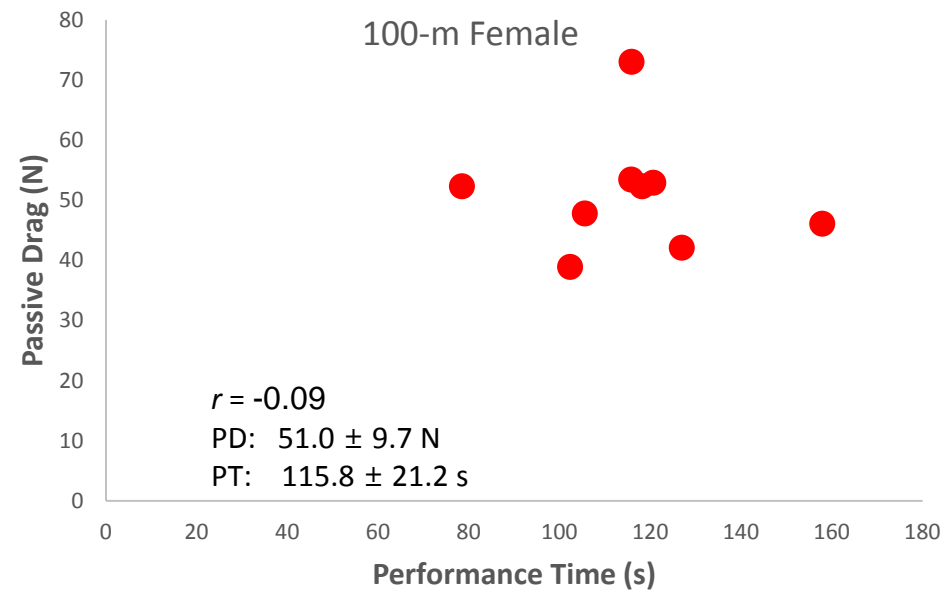
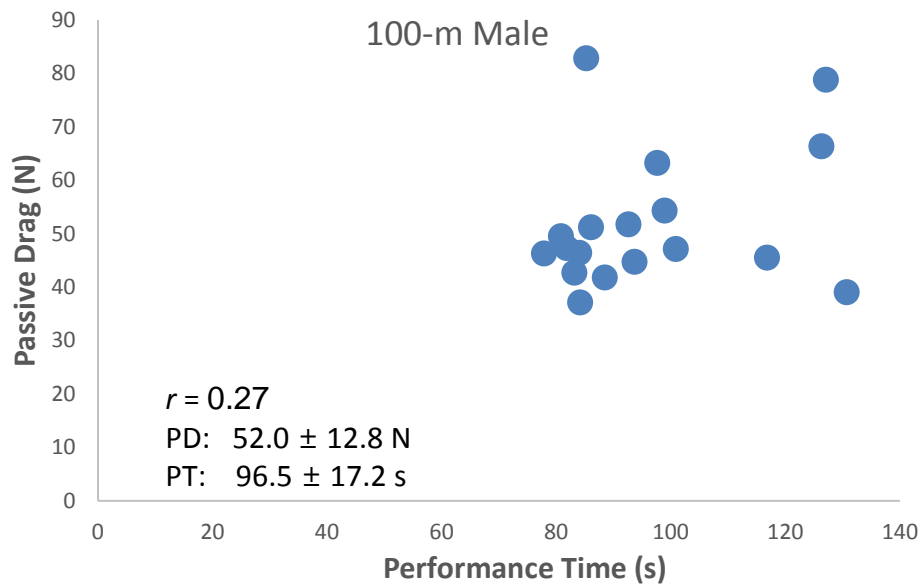
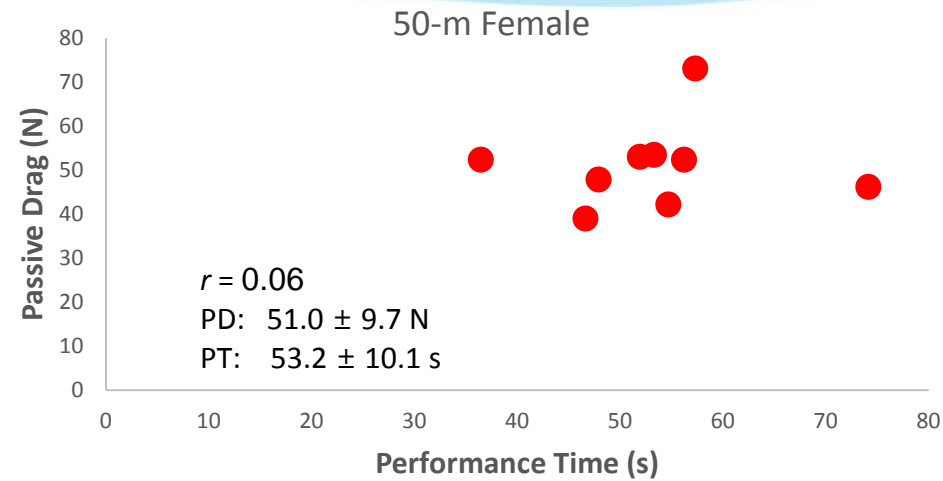
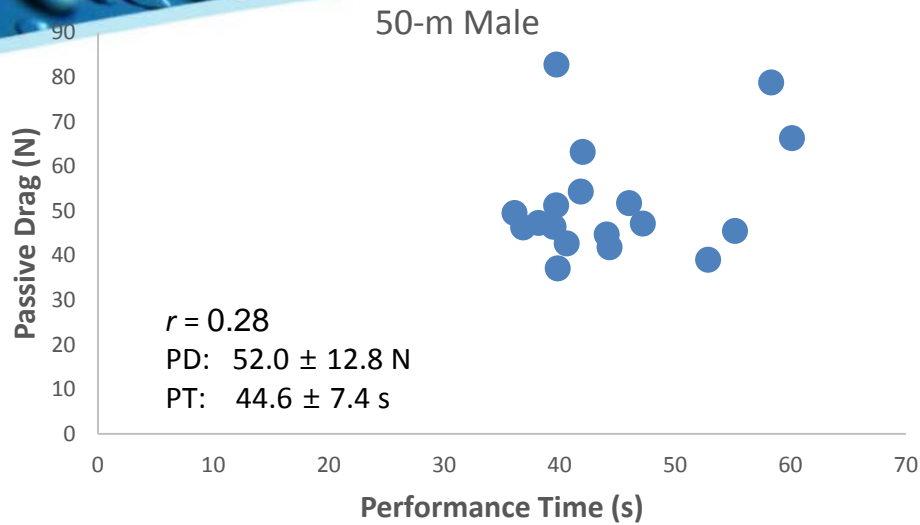
Results – PD vs PT (Classes S1-10)



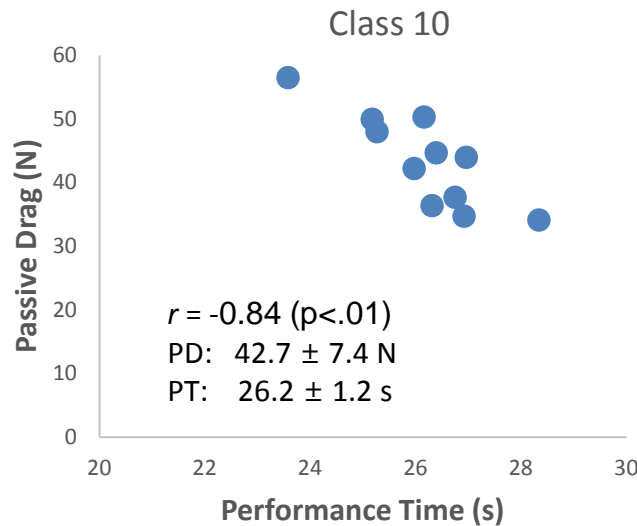
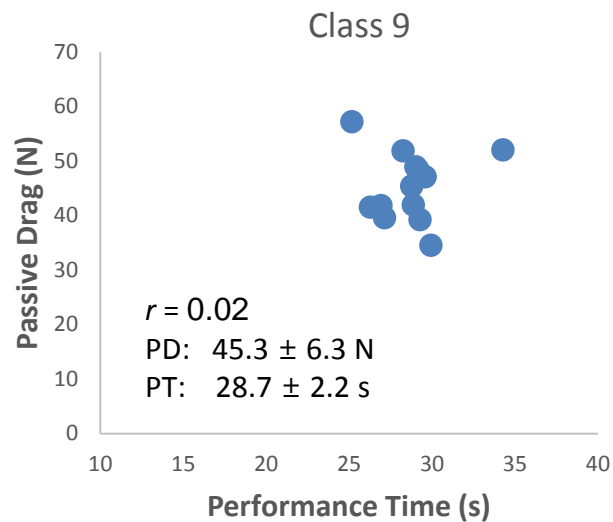
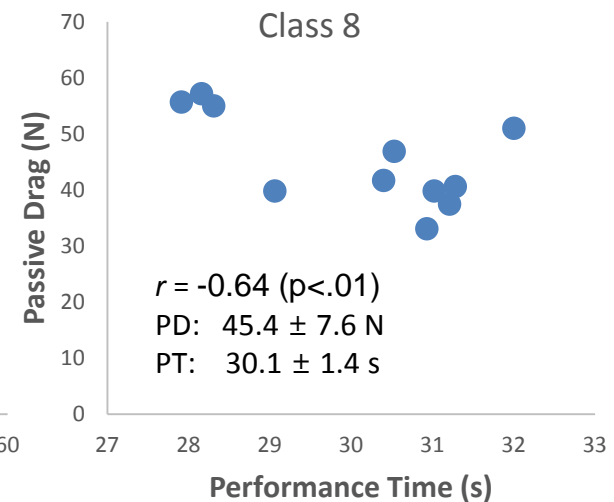
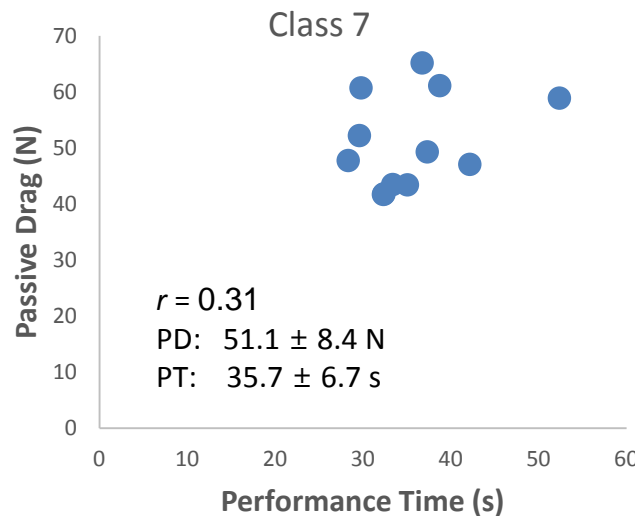
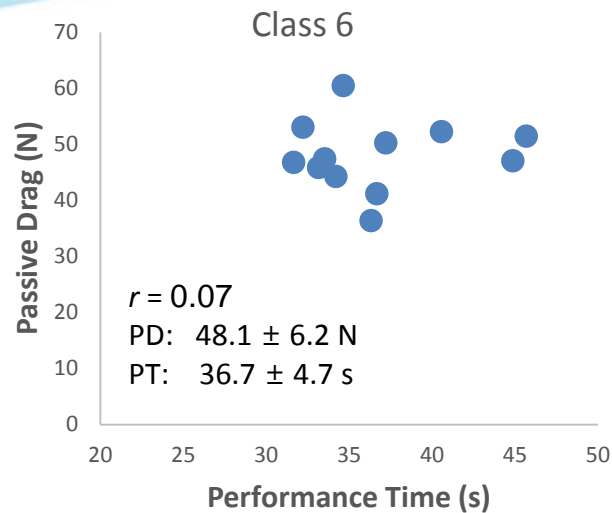
Results – PD vs PT (Classes S1-3)



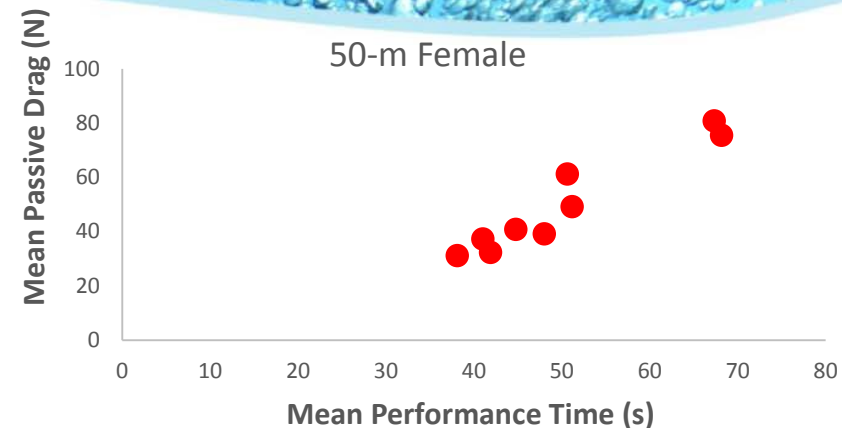
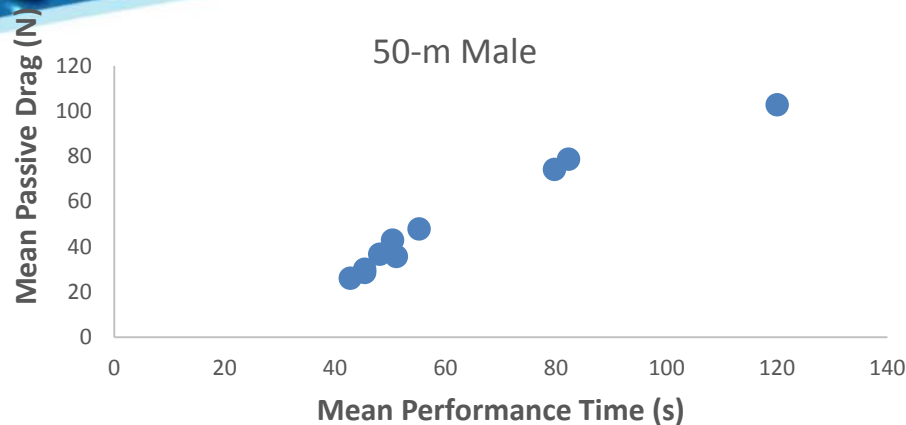
Results – PD vs PT (Classes S4-5)



Results – PD vs PT (Classes S6-10, 50-m Male)



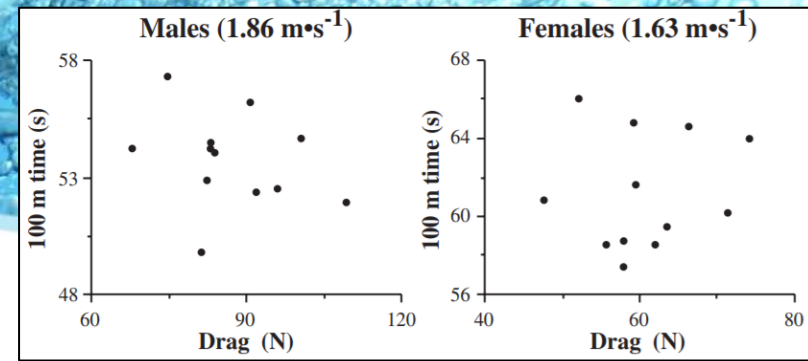
Results – Mean PD vs Mean PT



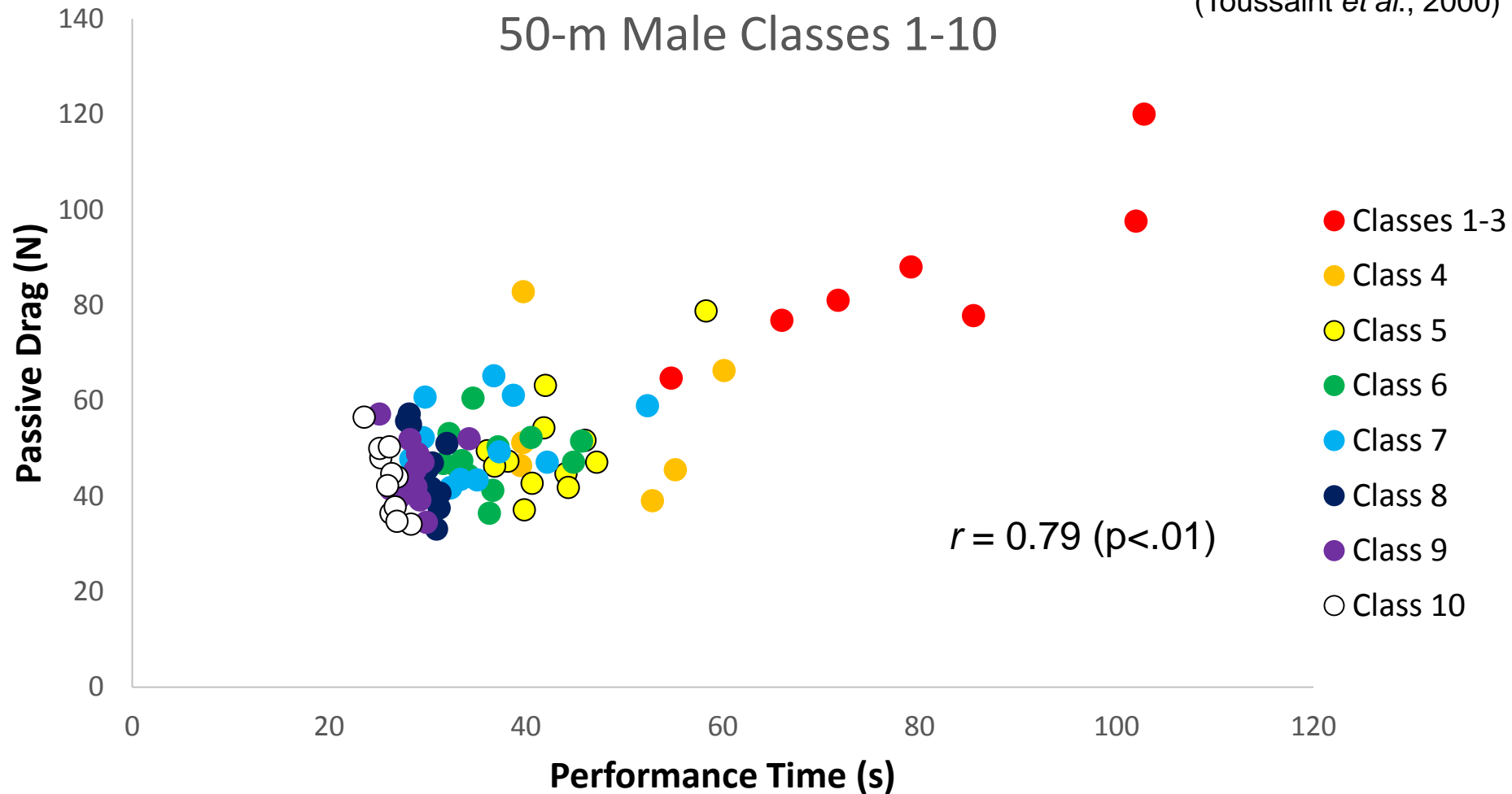
MALE	PD		PT	
	Mean	Stdev	Mean	Stdev
Class 1	120.0		102.8	
Class 2	82.3	5.2	78.8	6.9
Class 3	79.7	16.6	74.3	24.7
Class 4	55.2	16.3	47.9	9.3
Class 5	50.4	11.2	43.0	6.0
Class 6	48.1	6.2	36.7	4.7
Class 7	51.1	8.4	35.7	6.7
Class 8	45.4	7.6	30.1	1.4
Class 9	45.3	6.3	28.7	2.2
Class 10	42.7	7.4	26.2	1.2

FEMALE	PD		PT	
	Mean	Stdev	Mean	Stdev
Class 2	67.3		80.8	
Class 3	68.2	17.9	75.5	11.3
Class 4	50.6	3.9	61.3	11.3
Class 5	51.2	12.0	49.2	7.4
Class 6	48.0	10.3	39.2	3.3
Class 7	44.7	6.5	40.8	5.2
Class 8	41.0	8.9	37.3	1.7
Class 9	41.9	8.8	32.3	3.2
Class 10	38.1	6.9	31.2	2.0

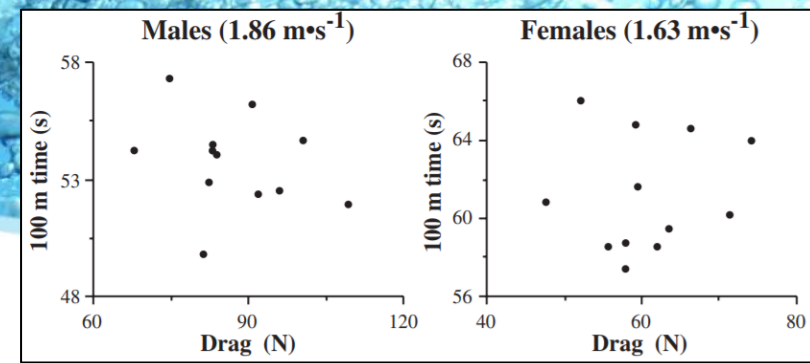
Discussion



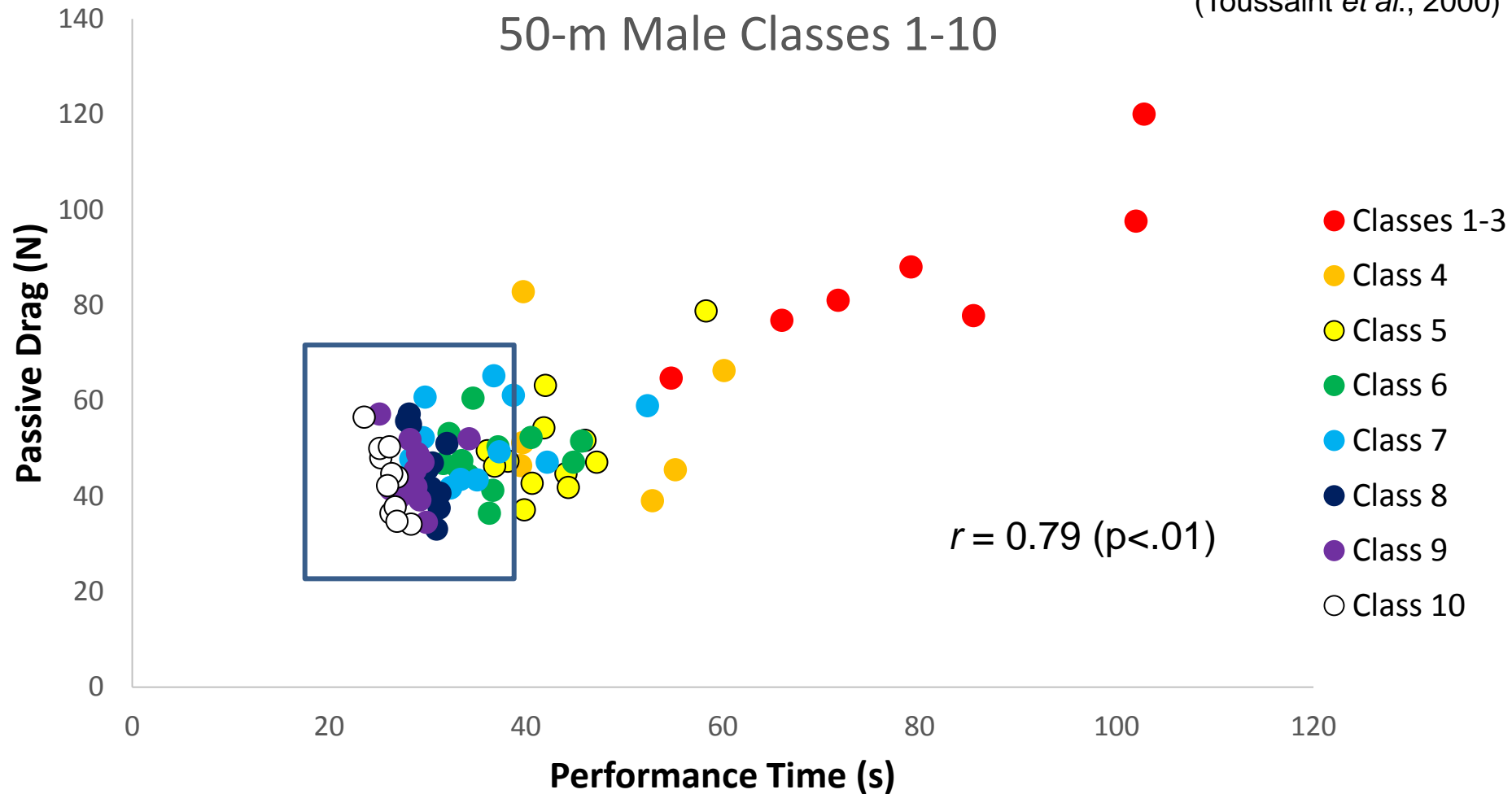
(Toussaint *et al.*, 2000)



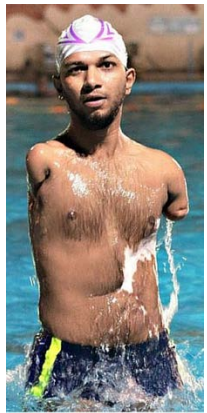
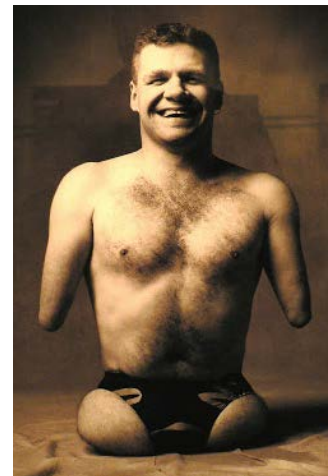
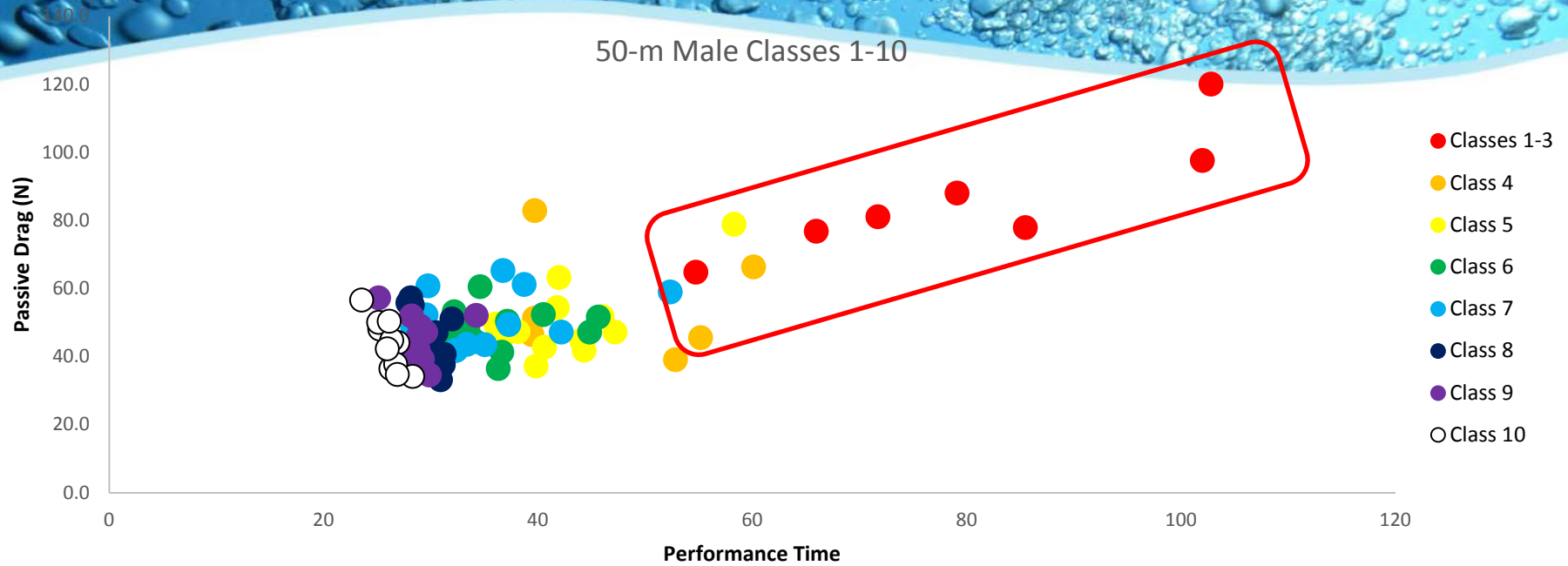
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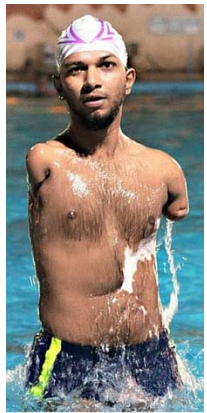
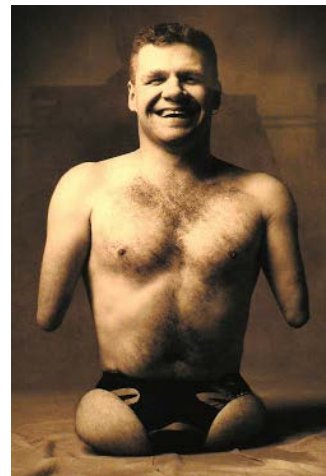
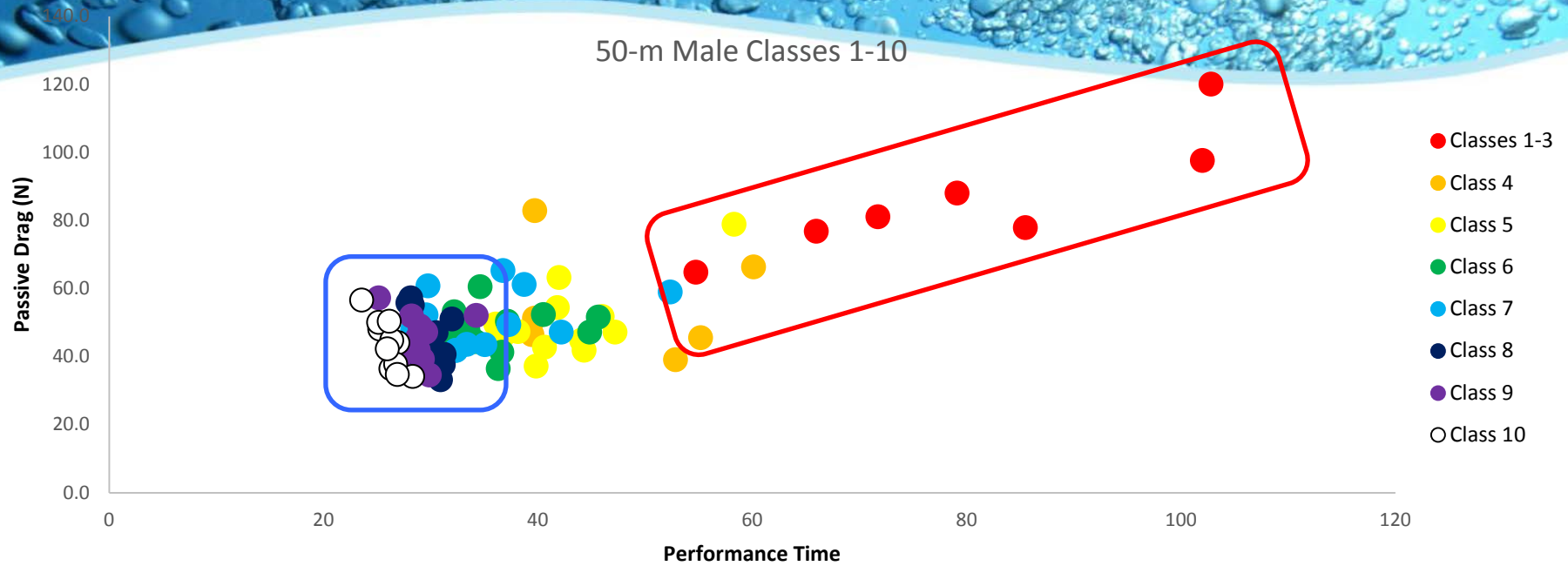
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Discussion



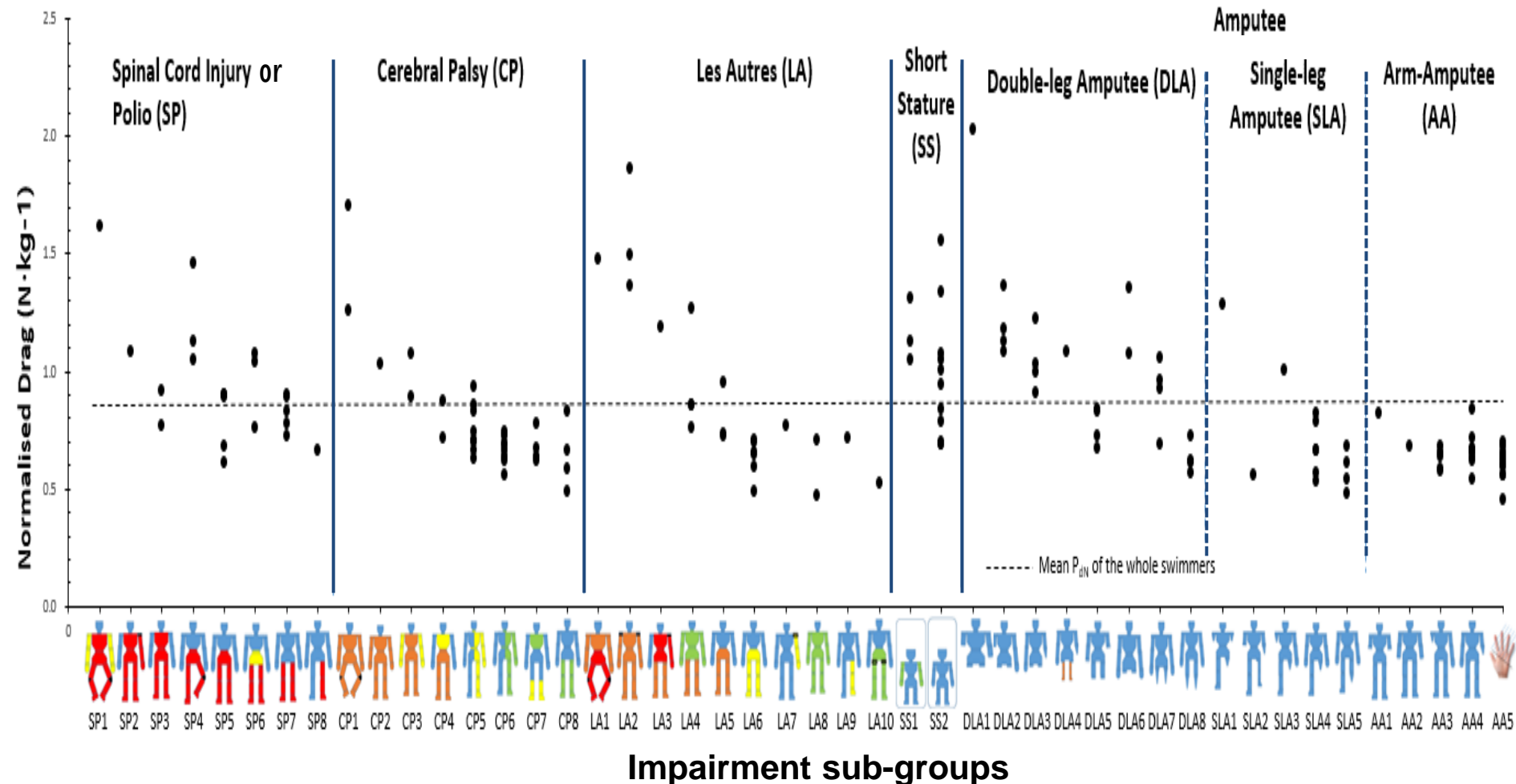
Discussion



Next Step: PD vs PT at Each Physical Impairment

• Passive drag vs Physical Impairment

(Oh *et al*, VISTA 2015)



Conclusion

- There exist **moderate - strong positive** correlations between PD and PT when the swimmers (S1-10) were considered as one group.
- There exists a **strong positive** correlation between PD and PT within the lower classes male-swimmers (S1-3).
- There are **No – strong negative** correlations between PD and PT at each mid-higher classes male swimmers (S4-10) and female swimmers at all classes (S1-10)
- Passive Drag appears to be a more important determinant of performance for **lower classed swimmers** than for higher classed swimmers.

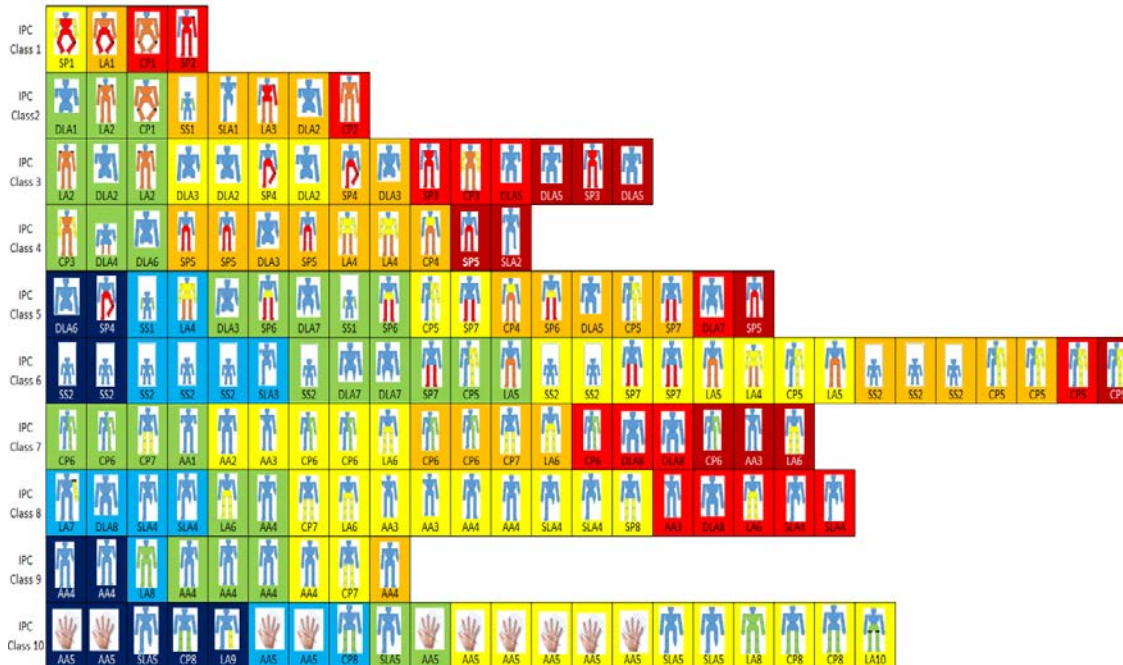
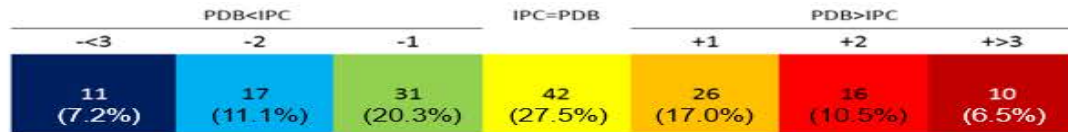
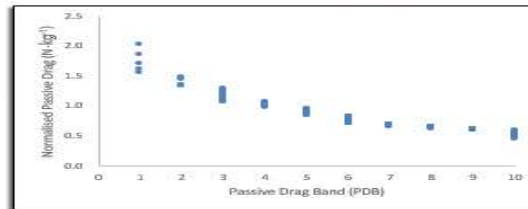
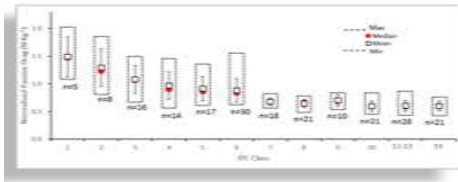
London 2012

Paralympic Games

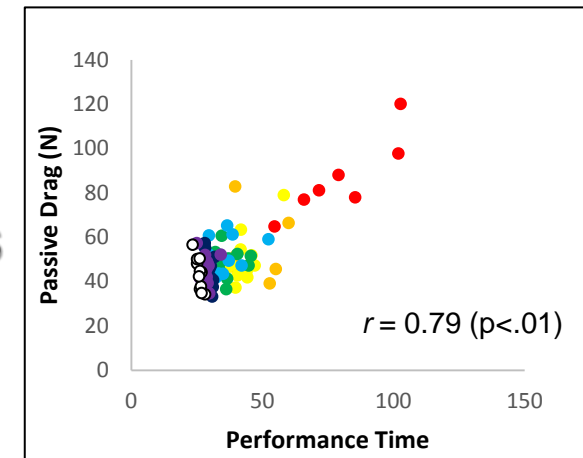


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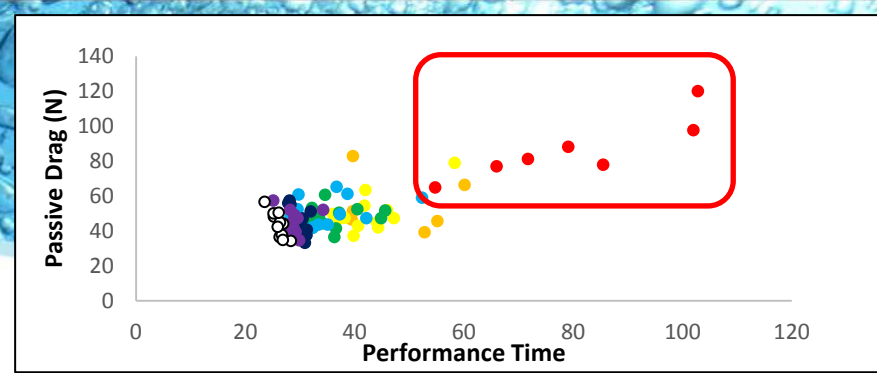
➤ Oh, Osborough, Burkett & Payton (VISTA 2015)



VS

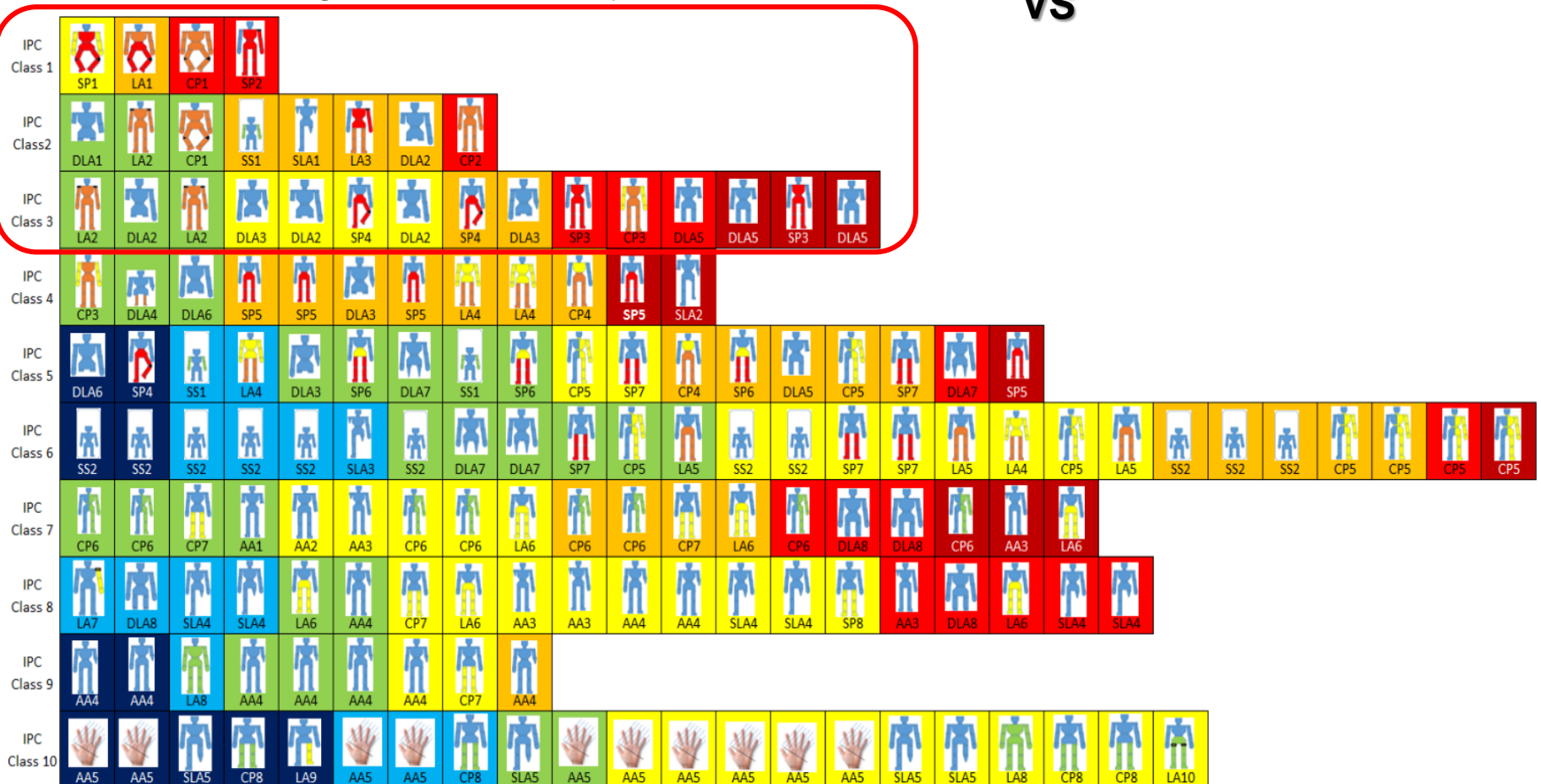


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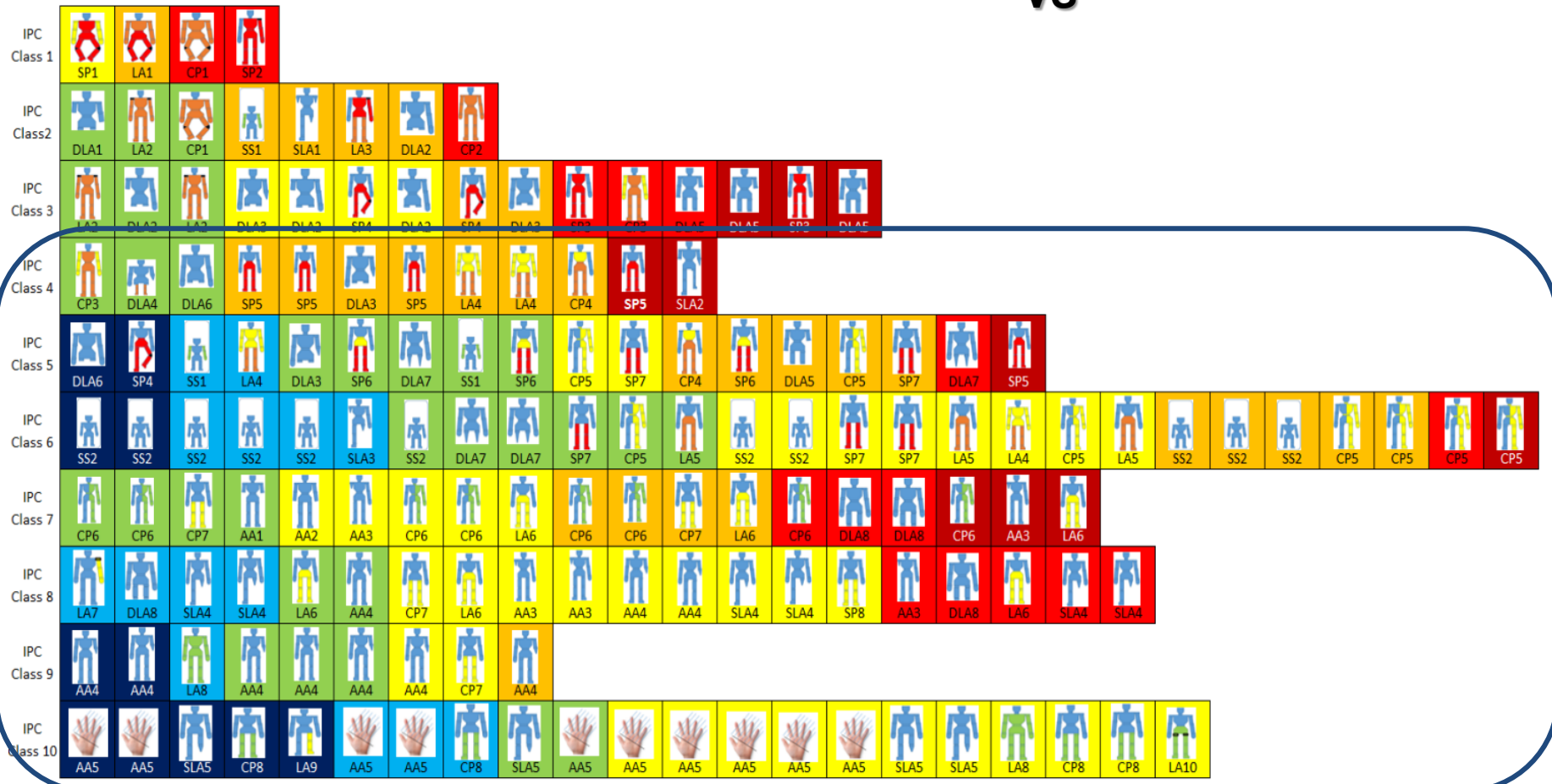
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VS



A scatter plot showing the relationship between Performance Time (x-axis) and Passive Drag (N) (y-axis). The x-axis ranges from 0 to 120, and the y-axis ranges from 0 to 140. The data points are colored in a gradient from purple to red. A blue rounded rectangle highlights a cluster of points in the lower-left region, indicating lower performance times and lower passive drag values.

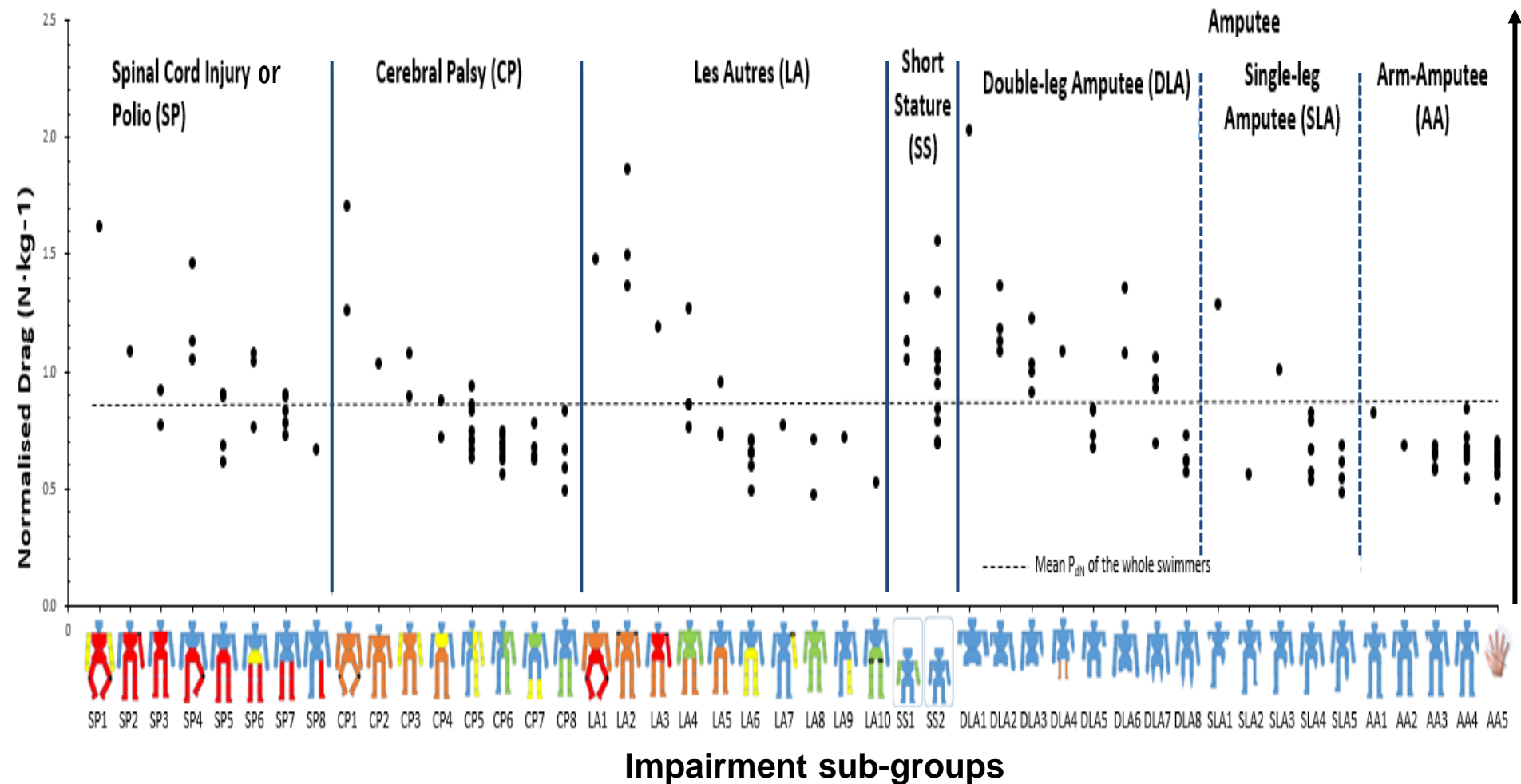
VS



Previous Research

- Passive drag vs Physical Impairment

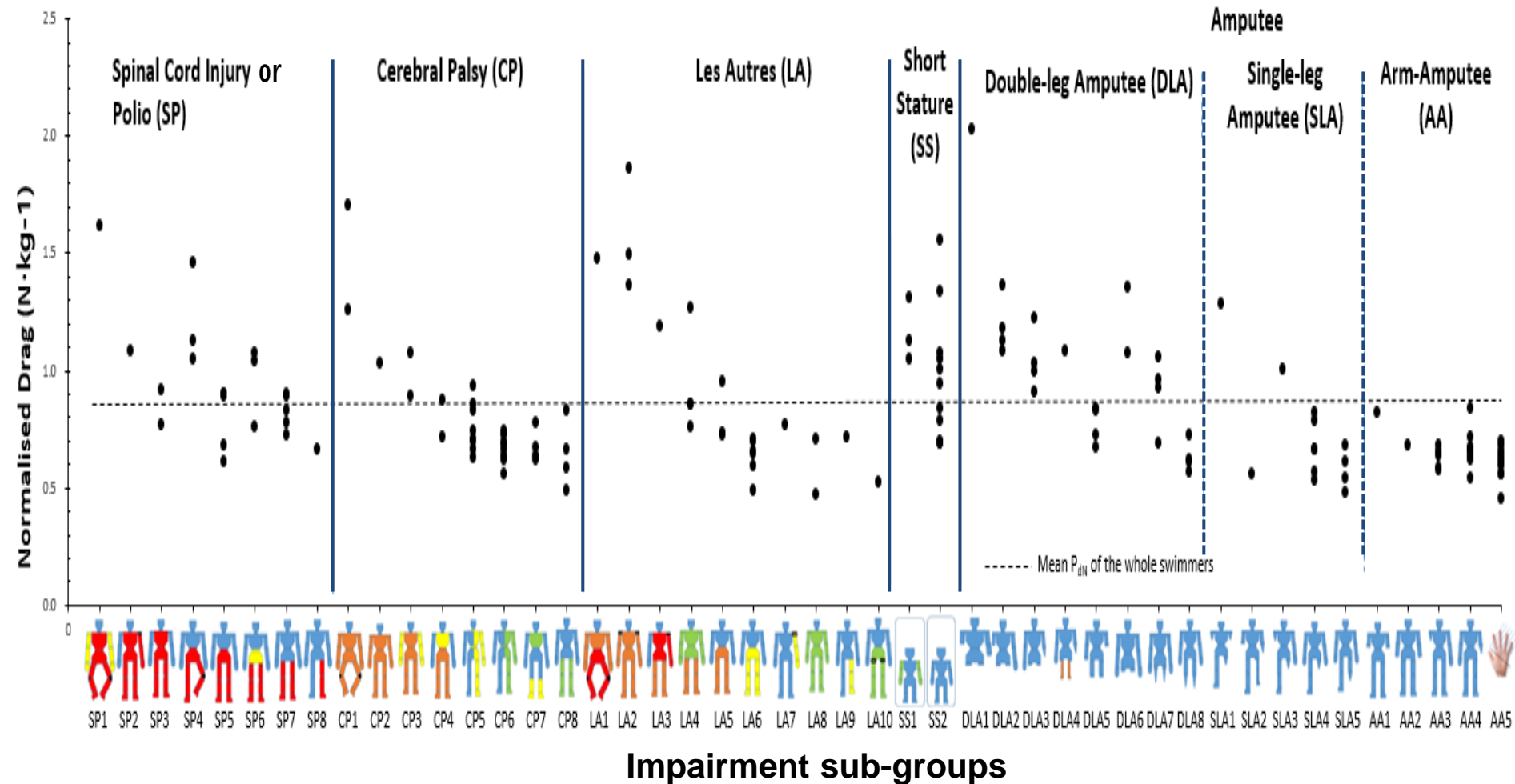
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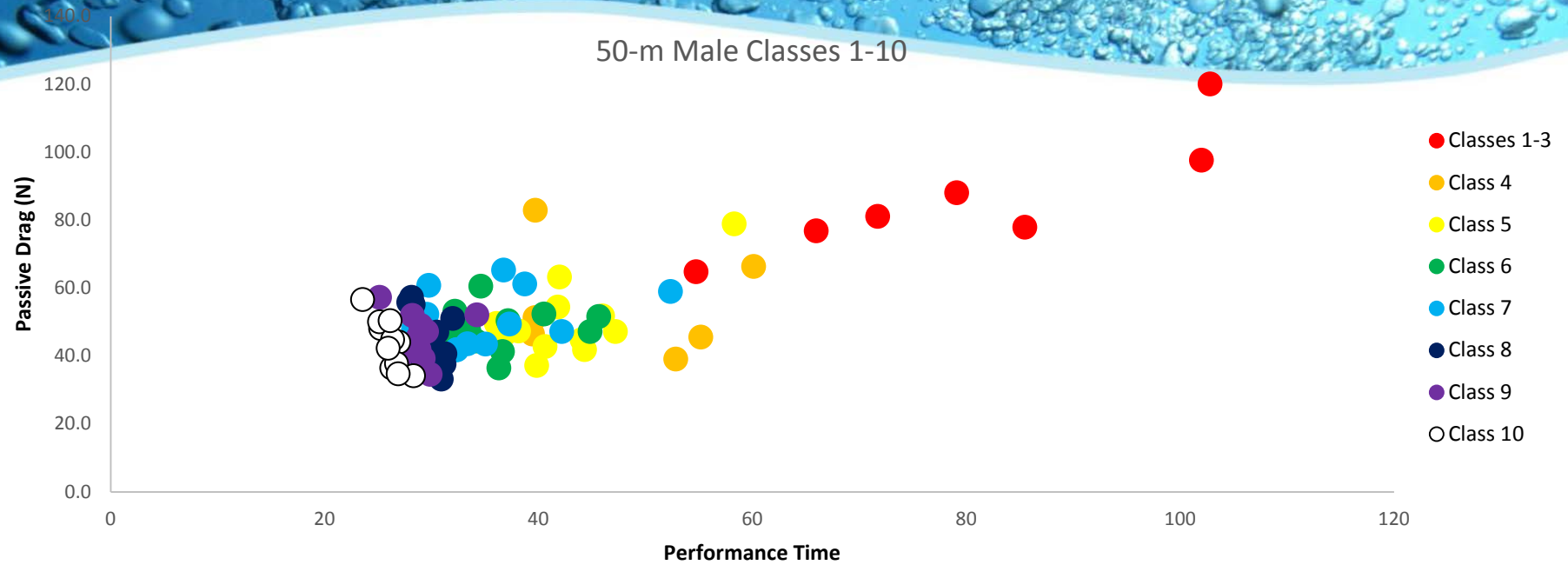
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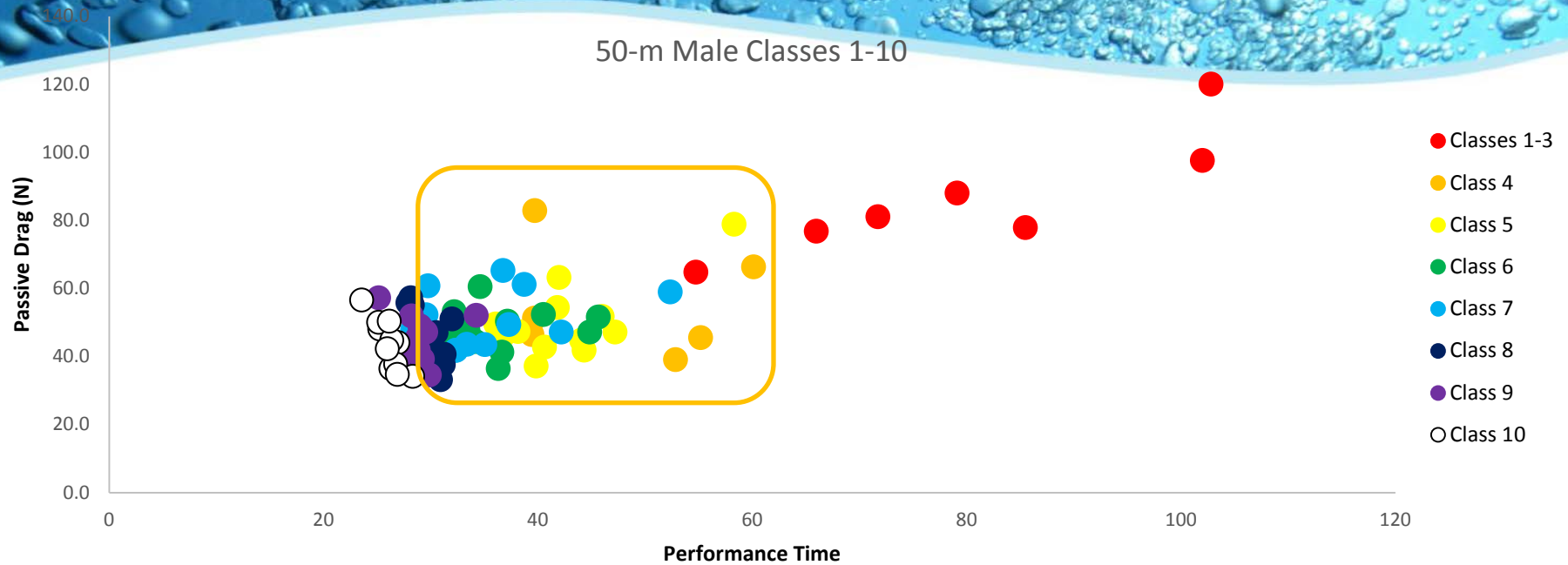


Discussion

50-m Male Classes 1-10



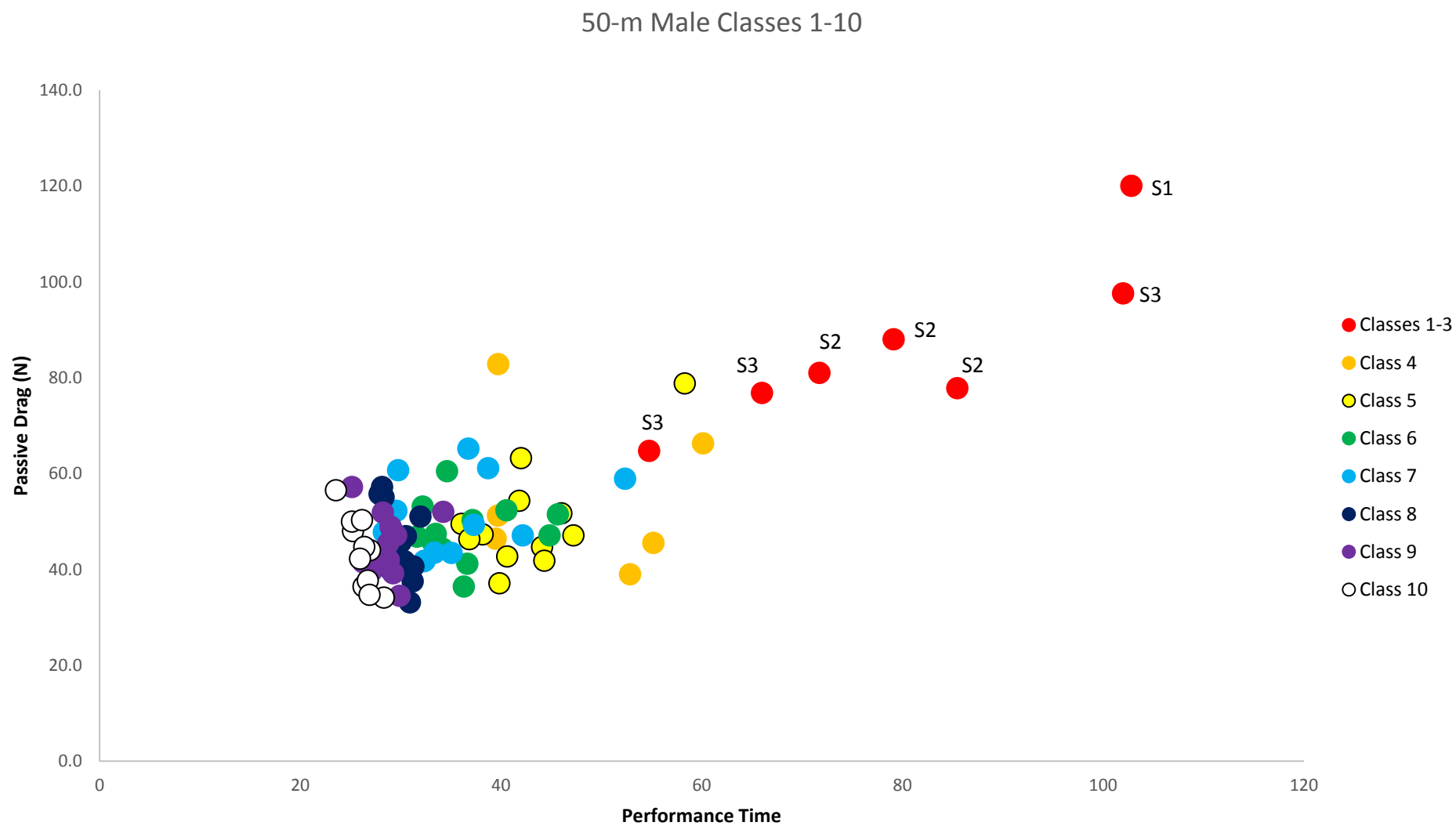
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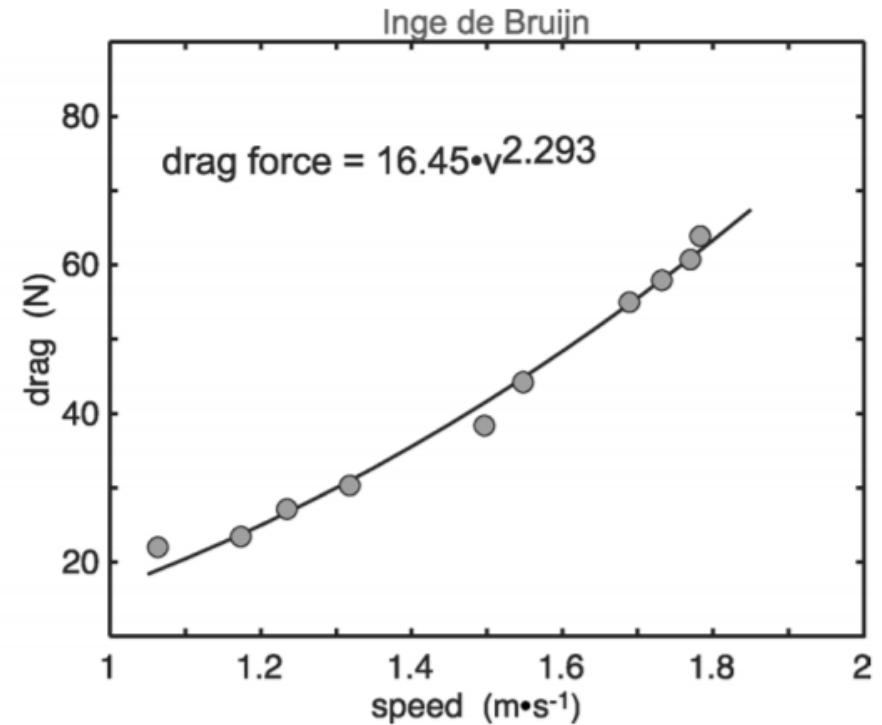
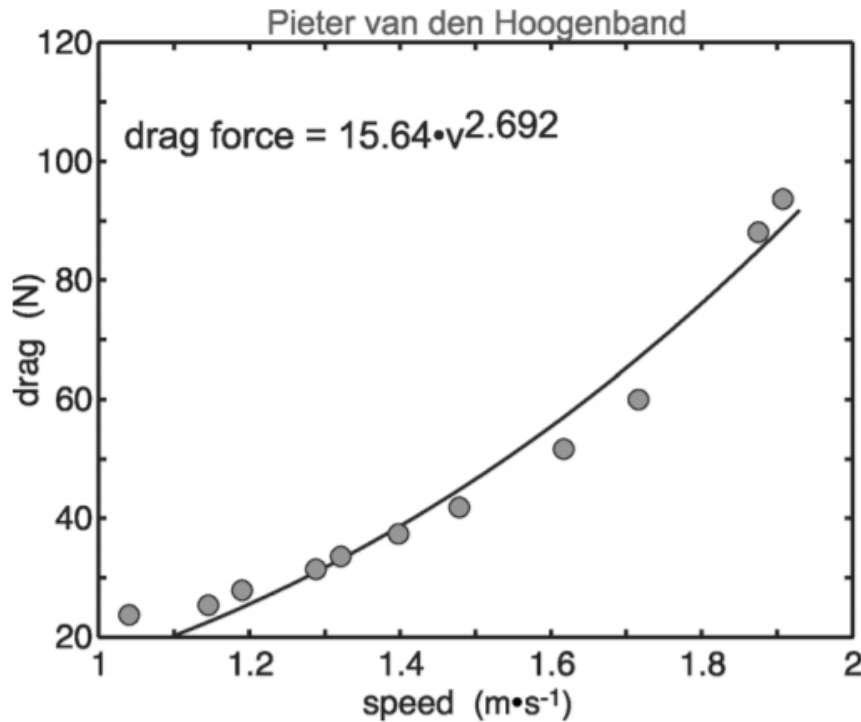
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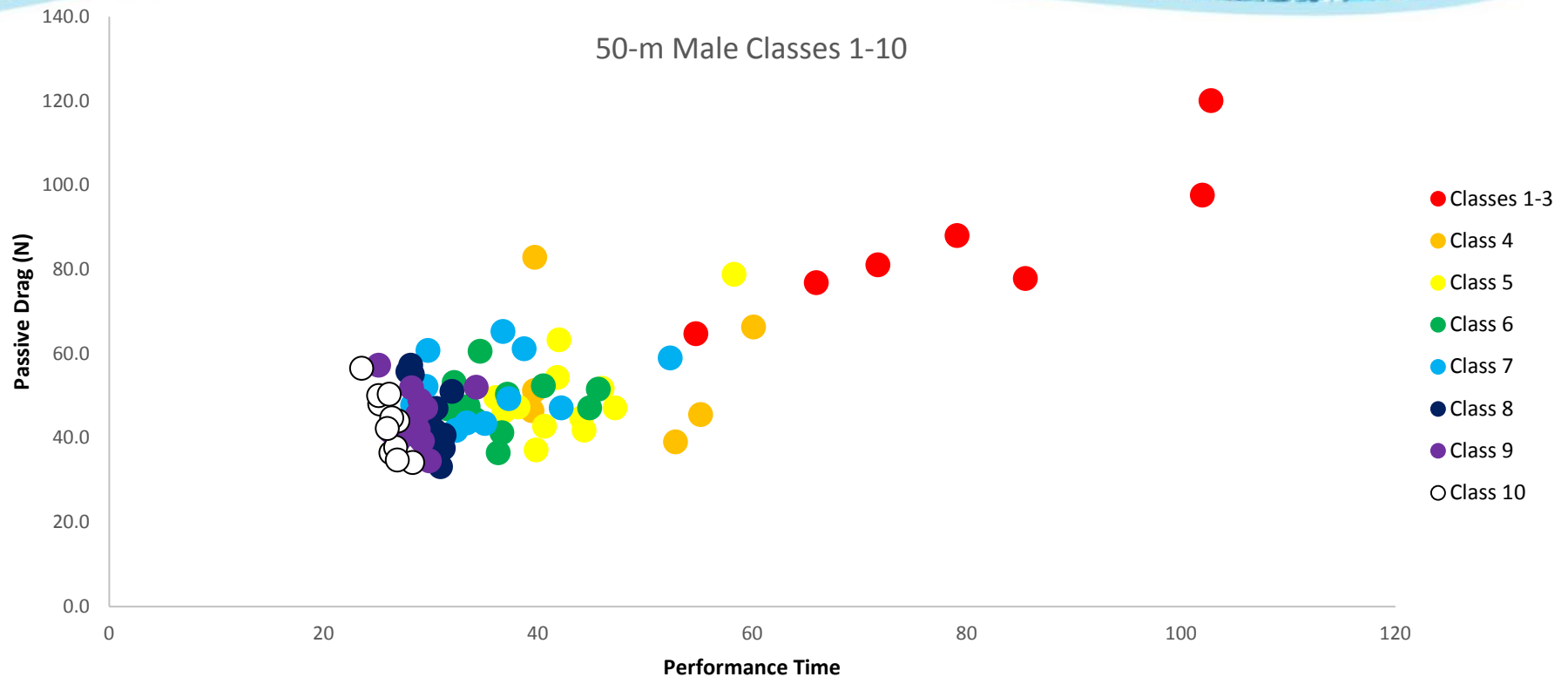
Introduction

$$D_p = \frac{1}{2} \rho A_p v^2 C_{Db} = k \cdot v^2$$



(Toussaint & Truijens, 2005)

Discussion



- Clear Trend at all classes (S1-10) show that PD is an important determinant for PT.
- Clear Trend at lower classes (S1-3) show that PD is an important for PT.
- No Trend at mid-higher classes (S4-10) show that different parameter (other than PD) is more important for PT.

Results

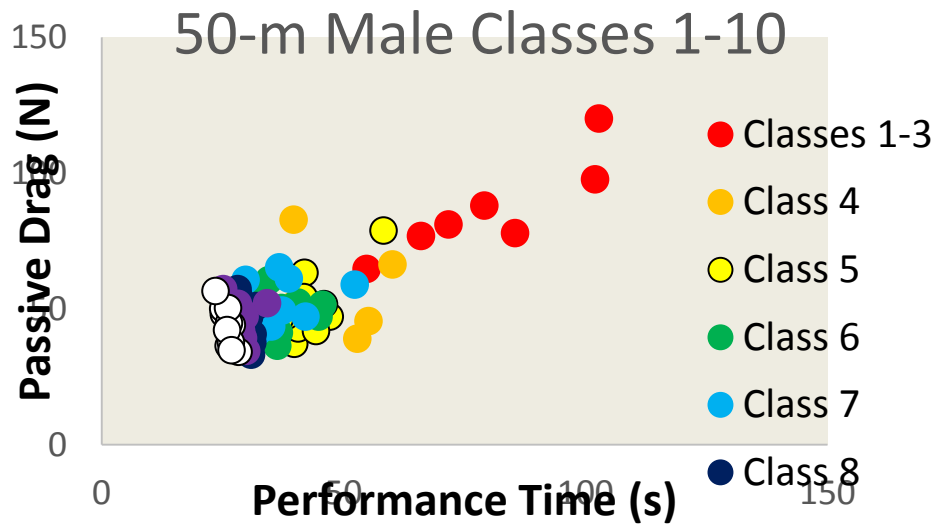
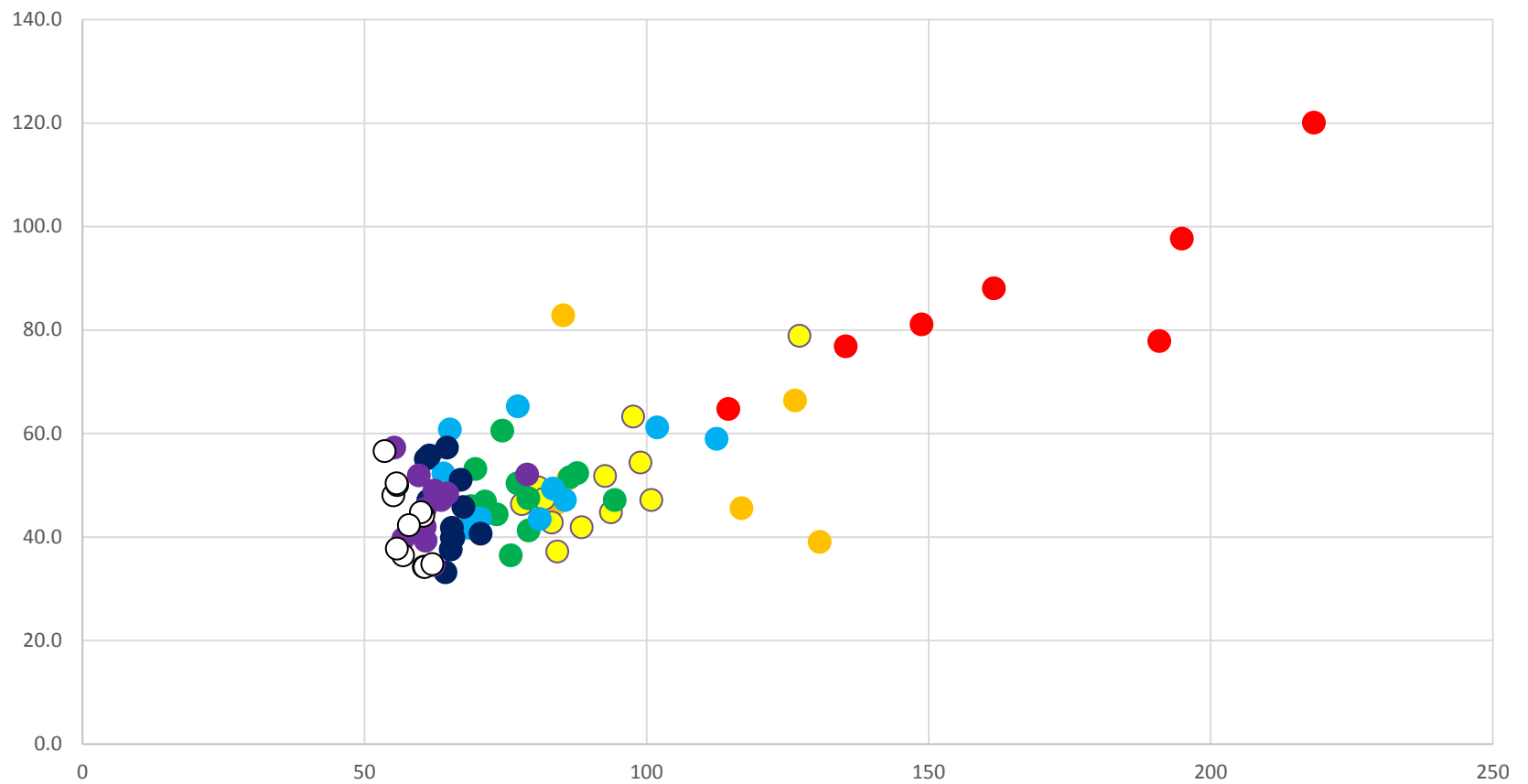




Chart Title



Discussion

- Mean PT and Mean PD has clear trend but notable reverse exists.
- Some outliers exist: The outliers has to be **Focused**.

