Physiological correlates to in-race paratriathlon cycling performance

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Abstract:	The purpose was to determine the physiological correlates to cycling performance within a competitive paratriathlon. Five wheelchair user and ten ambulant paratriathletes undertook laboratory-based testing to determine their: peak rate of oxygen uptake; blood lactate- and ventilatory-derived physiological thresholds; and, their maximal aerobic power. These variables were subsequently expressed in absolute (l·min-1 or W), relative (ml·kg-1·min-1 or W·kg-1) and scaled relative (or ml·kg-0.32·min-1 or W·kg-0.32) terms. All athletes undertook a paratriathlon race with 20 km cycle. Pearson's correlation test and linear regression analyses were produced between laboratory-derived variables and cycle performance to generate correlation coefficients (r), standard error of estimates and 95% confidence intervals. For wheelchair users, performance was most strongly correlated to relative aerobic lactate threshold (W·kg-1) (r=-0.99; confidence intervals: -0.99 to -0.99; standard error of estimate = 22 s). For ambulant paratriathletes, the greatest correlation was with maximal aerobic power (W·kg-0.32) (r=-0.91; -0.99 to -0.69; standard error of estimate = 88 s). Race-category-specificity exits regarding physiological correlates to cycling performance in a paratriathlon race with further differences between optimal scaling factors between paratriathletes. This suggests aerobic lactate threshold and maximal aerobic power are the pertinent variables to infer cycling performance for wheelchair users and ambulant paratriathletes, respectively.

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ABSTRACT

The purpose was to determine the physiological correlates to cycling performance within a competitive paratriathlon~~ race~~. Five wheelchair user ~~(PTWC)~~ and ten ambulant ~~(PTS)~~ ~~trained~~ paratriathletes undertook laboratory-based testing to determine their: peak rate of oxygen uptake; blood lactate- and ventilatory-derived physiological thresholds; and, their maximal aerobic power~~ (MAP)~~. These variables were subsequently expressed in absolute ($l\cdot min^{-1}$ or W), relative ($ml\cdot kg^{-1}\cdot min^{-1}$ or $W\cdot kg^{-1}$) and scaled relative (or $ml\cdot kg^{-0.32}\cdot min^{-1}$ or $W\cdot kg^{-0.32}$) terms. All athletes undertook a paratriathlon race ~~spanning the triathlon sprint distance~~with 20 km cycle. Pearson's correlation test and linear regression analyses were produced between laboratory-derived variables and cycle performance to generate correlation coefficients (r), standard error of estimates ~~(SEE)~~ and 95% confidence intervals~~ (CI)~~. For ~~PTWC~~wheelchair users, performance was most strongly correlated to relative aerobic lactate threshold ($W\cdot kg^{-1}$) (r=-0.99; confidence intervals~~CI~~: -0.99 to -0.99; ~~SEE~~ standard error of estimate = 22 s). For ~~PTS~~ambulant paratriathletes, the greatest correlation was with ~~MAP~~ maximal aerobic power ($W\cdot kg^{-0.32}$) (r=-0.91;~~ CI:~~ -0.99 to -0.69; ~~SEE~~ standard error of estimate = 88 s). Race-category-specificity exits regarding physiological correlates to cycling performance in a paratriathlon race with further differences between optimal scaling factors between ~~PTWC and PTS~~ paratriathletes. This ~~study~~ suggests aerobic lactate threshold and ~~MAP~~ maximal aerobic power are the pertinent variables to infer cycling performance for ~~trained~~ wheelchair users and ambulant paratriathletes ~~PTWC and PTS paratriathletes~~, respectively.

Key words: Prediction, talent identification, monitoring, peak power output, triathlon, time-trial

INTRODUCTION

Several studies have assessed physiological correlates to endurance cycling performance with Fischer et al. [1] extending research into the handcycling domain in a group of Paralympic athletes, albeit of homogeneous impairments. However, there has been little attention paid to cycling performance within triathlon and no research in paratriathlon, the Paralympic variant of the sport. Cycling ~~duration~~ sport modality accounts for ~50% of triathlon race time thus can have a large influence on athletes' overall race performance. Therefore, understanding correlates to in-race cycling performance would provide information to coaches and practitioners regarding meaningful tests that may indicate athletes' performance level. Such tests may aid longitudinal monitoring or talent identification but should acknowledge the need for specificity exists across impairment groups.

It has long been known that the peak rate of oxygen uptake (VO_{2peak}) is related to endurance performance in heterogeneous populations [2]. However, it is also well accepted that physiological thresholds, derived from blood lactate concentration (BLa) and/or ventilatory variables, may be more applicable to homogenous, trained athlete groups [3]. Previous studies have investigated the correlation between VO_{2peak}, physiological thresholds, sustainable workloads achieved during incremental laboratory tests and cycling performance. Whilst physiological thresholds display greater correlations than VO_{2peak} [4-6], peak power output attained during incremental tests to exhaustion have the greatest association [4, 5, 7-10], independent of the performance duration [8]. This relationship still applies regardless of whether peak power output is recorded during short (10-12 min), ramp-based tests or prolonged (20-30 min) ~~incremental~~ stepwise tests, the former being synonymous with maximal aerobic power (MAP) [11].

The power output associated with physiological thresholds or MAP can be expressed in absolute (W) or relative ($W \cdot kg^{-1}$) terms. To negate the positive influence body mass has on flat cycling performance in able-bodies athletes, a scaling exponent of 0.32 has been used and has been shown to be a better predictor of performance [12]. However, it is not currently known how applicable scaling factors may be for Paralympic athletes. Although research has suggested the mass exponent of 0.82 is used for scaling $\dot{V}O_{2peak}$ in wheelchair racers with a spinal cord injury [13], no research has investigated athletes when cycling. It is likely that limb deficiencies, prostheses use, and muscle paralysis may all obscure the relationship between body mass and cycling performance. Furthermore, it is unclear what the best representation of values may be for handcyclists considering the differing propulsion techniques. The aim of this study was therefore to determine the degree of association between $\dot{V}O_{2peak}$, physiological thresholds, MAP and paratriathlon in-race cycling performance. Furthermore, this study aimed to assess the appropriateness of commonly used scaling factors for physiological variables, acknowledging the variability within Paralympic athlete cohorts. ~~any race-category specificity would be explored acknowledging the variability within Paralympic cohorts and differing representations of physiological variables would be considered.~~

METHODS

Subjects

Fifteen trained paratriathletes (four female) of mixed impairments volunteered to partake in this study, their characteristics are displayed in Table 1. To assess race-category-specificity, acknowledging the largely disparate demands of handcycling and cycling, the cohort was split into wheelchair users (PTWC; *n*=5) and ambulant athletes (PTS; *n*=10). Athletes all visited the laboratory for cycling-based physiological testing in the months of June to August 2014, thus in the paratriathlon competition season. Athletes also took part in a competitive paratriathlon race on 10th August 2014. For one athlete, this was five days before his laboratory test, for all others the race was one to eight weeks post-testing. All provided written informed consent and the procedures were approved by the University Ethical Advisory Committee and conformed to the standards set by Harriss et al. [14].

Insert Table 1 here

Laboratory test

Initially, athletes' body mass was recorded via electronic scales (Detecto 6550, Webb City, MO, USA) to the nearest 0.1 kg. Athletes' bicycle or handcycle was subsequently fixed to the Cyclus 2 ergometer (RBM elektronik-automation GmbH, Leipzig, Germany). The ergometer prevented position unfamiliarity and lack of ecological validity. Athletes were permitted a self-selected warm-up before first undertaking a 30 s Wingate test for anaerobic capacity (data not shown). Afterwards, athletes were provided 30 min recovery before the commencement of the submaximal test. This test started at a workload of 20 W (PTWC) or 75 W (PTS). Thereafter, power output increased 20 W (PTWC) or 25 W (PTS) every three minutes. Gas exchange variables were collected throughout the test for determination of the rate of oxygen uptake ($\dot{V}O_2$), rate of carbon dioxide production ($\dot{V}CO_2$) and rate of expired air ($\dot{V}_E$) (Metalyzer® 3B, Cortex Biophysik GmbH, Leipzig, Germany). Capillary blood samples were collected from an earlobe at the end of every workload stage for the determination of BLa via calibrated lactate analyser (Biosen C-Line, EKF Diagnostics, Magdeburg, Germany). The submaximal test was terminated when BLa exceeded 4.0 $mmol \cdot l^{-1}$.

Upon completion of the submaximal test, athletes were given 30 min of recovery before the start of the maximal test. This test began at a workload assumed to be athletes' aerobic lactate threshold (AeLT; see below). Athletes cycled at this power output for two minutes. This starting workload was deemed low enough that no significant divergence in $\dot{V}O_2$

and $\dot{V}CO_2$ would occur within the first 5 min of the test [7]. The workload was subsequently increased by 5 W every 15 s. Athletes were instructed to cycle until volitional exhaustion with the test terminated when cycling cadence dropped below 70 revolution·min^{-1} despite vocal encouragement. During the test, expired air was analysed continuously, as above. Although recovery periods were provided between sections of the testing protocol, fatigue from preceding elements (Wingate or submaximal test) may have caused underperformance during the maximal test. Whilst some level of individual variation would have occurred, we aimed to standardise timings to minimise this interference.

Test outcome variables

Firstly, AeLT was determined via log-log transformation of $\dot{V}O_2$ and BLa [15]. Two linear regression lines were fitted to the horizontal and ascending parts of the BLa–$\dot{V}O_2$ relationship data, and the BLa at the intersection of the regression lines was defined as AeLT. Further, anaerobic lactate threshold (AnLT) accepted as the workload associated with a BLa 1.5 mmol·l^{-1} greater than AeLT [16]. Additionally, the onset of blood lactate (OBLA) was defined as the workload allied to a BLa of 4.0 mmol·l^{-1} [17]. Ventilatory threshold (VT) was defined as the power output corresponding to a systematic increase in the ventilatory equivalent of oxygen ($\dot{V}_E \cdot \dot{V}O_2^{-1}$) without a concomitant increase in the ventilatory equivalent of carbon dioxide ($\dot{V}_E \cdot \dot{V}CO_2^{-1}$) during the maximal test [7, 18]. $\dot{V}O_{2peak}$ was accepted as the highest $\dot{V}O_2$ value recorded during any 30 s epoch. Lastly, MAP was defined as the average power output during the final minute of the maximal test.

All variables are presented as the absolute power output (W) at which they occur. Additionally, variables are presented relative to body mass recorded during laboratory tests (W·kg^{-1}) and relative to body mass adjusted to the power of 0.32 (W·kg$^{-0.32}$). $\dot{V}O_{2peak}$ is also presented in absolute ($l \cdot min^{-1}$), relative ($ml \cdot kg^{-1} \cdot min^{-1}$) and scaled for PTWC ($ml \cdot kg^{-0.82} \cdot min^{-1}$) (13) and PTS athletes ($ml \cdot kg^{-0.32} \cdot min^{-1}$).

Paratriathlon race

The race completed by athletes was of triathlon sprint distance typical of paratriathlon and acted as a national championship event. It consisted of a 750 m open water swim; flat, non-drafting 20 km cycle; and 5 km run located in Liverpool, UK (elevation 70 m). Aligned to ITU paratriathlon competition rules, PTWC athletes used a handcycle and racing wheelchair for cycle and run sections, respectively. Ambulant sport categories used prostheses or adaptations to bicycles, where necessary. Environmental conditions during the races were: 15.7 ± 1.1°C air temperature, 89 ± 7% relative humidity and 17 ± 14 $km \cdot h^{-1}$ wind velocity. No precipitation was recorded during the race. Athletes' race results and segment times were recorded by the race organiser and published online. The cycling segment time was the sole measure used for analysis from the race results to maintain modality continuity with laboratory tests.

Statistical Analyses

All statistical analyses were conducted using IBM SPSS Statistics 23.0 software (IBM, New York, USA). Statistical significance was set at $p<0.05$. Data were checked for normal distribution using the Shapiro-Wilk test. Within groups, the relationship between race cycling segment time and laboratory-derived variables was assessed via Pearson product correlations and linear regression analysis. Correlations were interpreted according to the absolute criteria with thresholds of 0.1, 0.3, 0.5, 0.7 and 0.9 for small, moderate, large, very large and extremely large correlation coefficients [19, 20]. Standard error of estimate (SEE) and 95% confidence intervals (CI) were produced for all variables significantly related to race cycling time. Values are shown as mean ± standard deviation (SD).

RESULTS

The mean total race time for PTWC paratriathletes was 72.4 ± 8.7 min, of which 5.8 ± 1.2 min were transitions. Cycle time was 36.4 ± 4.0 min (55 ± 2% race time, excluding transitions). There were significant very large to extremely large correlations noted between race cycling time and: absolute AeLT, AnLT and OBLA (W); relative AeLT, AnLT and OBLA (W·kg^{-1}); scaled relative AeLT, AnLT, OBLA and MAP (W·kg$^{-0.32}$) ($p \leq 0.035$; Figure 1; Table 2). There was no significant correlation to body mass (r = -0.03; p = 0.964).

Insert Figure 1 here

Insert Table 2 here

The mean total race time for PTS paratriathletes was 76.8 ± 8.3 min, of which 6.3 ± 1.3 min were transitions. Cycle time was 35.6 ± 3.6 min (50 ± 2% race time, excluding transitions). There were significant large to extremely large correlations noted between race cycle time and: absolute AeLT, AnLT, OBLA, VT, MAP and $\dot{V}O_{2peak}$ (W or l·min^{-1}); relative VT, MAP and $\dot{V}O_{2peak}$ (W·kg^{-1} or ml·kg^{-1}·min^{-1}); scaled relative AeLT, AnLT, OBLA, VT, MAP and $\dot{V}O_{2peak}$ (W·kg$^{-0.32}$ or ml·kg$^{-0.32}$·min^{-1}) ($p \leq 0.033$; Figure 2; Table 3). There was no significant correlation to body mass (r = -0.49; p = 0.150).

Insert Figure 2 here

Insert Table 3 here

DISCUSSION

The main finding from this study is that laboratory-derived physiological and performance variables significantly correlate to, and may predict, cycle segment times in a paratriathlon race. However, there appears to be race-category-specificity with stronger relationships noted for lower intensity parameters for PTWC paratriathletes with the opposite true for PTS paratriathletes.

Several studies have sought to determine the degree of associated between laboratory-derived physiological variables and simulated or real-world cycling time-trial performance over varying durations in able-bodied athletes [4-12, 21]. It has consistently been shown that peak power output from ~~incremental~~ stepwise (20-30 min) and ramp (10-12 min) tests to exhaustion relate to cycling performance. In the current study, MAP ($W \cdot kg^{-0.32}$) was the best predictor of cycling time in ambulant paratriathletes. Furthermore, this measure was significantly related to cycling time in PTWC athletes. The tolerance limit when cycling at MAP has been shown to be ~4 min in well-trained cyclists [22], thus well below the duration of the cycle segment in the paratriathlon race. Nonetheless, as Borszcz et al. [8] state, MAP is highly associated with cycling time trial performance, in spite of the duration. Moreover, Balmer et al. [11] have previously reported a low coefficient of variation of MAP (1.3%), when determined as in methods of the current study. Due to the high relationship to cycling performance, its low variability and the quick nature of which MAP can be tested, it may be proposed that testing this variable is the best method of interfering performance potential in athletes. This testing would be less disruptive to athletes' routines than a simulated or real-world time-trial and may provide valuable information for longitudinal performance monitoring or talent identification in ambulant paratriathletes. An added benefit of this is the lack of requirement for expensive equipment to calculate gas exchange variables or BLa as MAP is solely derived from power output.

Although MAP ($W \cdot kg^{-0.32}$) significantly related to cycling time in PTWC athletes, there was a lower SEE for AeLT, AnLT and OBLA variables, with AeLT ($W \cdot kg^{-1}$) providing the best predictive capability. Although the depth of research centred on physiological correlates to handcycling performance is limited, Fischer et al. [1] did investigate relationships to a 22 km time-trial in seven athletes with paraplegia. The authors noted that power output at first ventilatory threshold (determined by visual inspection) displayed an extremely large (r=-0.95) relationship to time-trial performance time. It is noteworthy that the study of Fischer et al. [1] is corroborated currently in PTWC paratriathletes handcycling and indicates a uniqueness to this exercise modality. The race cycling time was greater for PTWC paratriathletes than ambulant PTS paratriathletes, thus it is likely to be performed at a lower relative intensity. Consequently, it is intuitive that handcycling performance displays a closer relationship to physiological variables of a lower relative intensity, although the tolerable limit at AeLT (2-3 h) [23] is much greater than the race duration. Whilst testing MAP may be most applicable for ambulant paratriathletes, it appears AeLT is the physiological variable most pertinent for PTWC athletes. This necessitates the calculation of $\dot{V}O_2$ and BLa, using the methods of Beaver et al. [15], thus may be burdensome from an equipment perspective. Future research may investigate how differing methods of first lactate and/or ventilatory threshold identification relate to handcycling performance to ease the testing process.

For ambulant PTS paratriathletes, representing laboratory variables relative to a body mass exponent of 0.32 ~~resulted in little improvement~~showed little difference in correlation coefficients compared to absolute values. However, when variables were represented relative to non-scaled body mass, there was a~~ere~~ noticeablye ~~reductions in the strength of relationships~~lower correlation coefficient. Conversely, for PTWC paratriathletes, the greatest correlation coefficients occurred when values were represented relative to non-scaled body mass for most variables. This again indicates that race-category-specificity is required when considering performance correlates in paratriathletes. Scaling body mass to the power of 0.32 was proposed by Swain [21] to negate the benefit of body mass during cycling performance on a flat course, although the relationship between body mass and cycling performance did not reach significance for ambulant athletes here. Lamberts et al. [9] subsequently reported that this scaling factor significantly improved the relationship between MAP and $\dot{V}O_{2peak}$ to performance in a simulated 40 km time-trial compared to absolute values. The incongruence between the findings of Lamberts et al. [9] and here, with respect to ambulant PTS paratriathletes, may relate to the impact limb deficiencies, prostheses use, and limb immobilisation has on scaling factors. With the highly heterogeneous populations common in Paralympic sport, it is unlikely that a single scaling factor for body mass may best relate to flat cycling performance. Further research is therefore warranted to investigate if the relationship to body mass$^{0.32}$ can be bettered. That values relative to non-scaled body mass best predict PTWC race cycling time is not wholly surprising. Unlike cycling for ambulant athletes, there is a lot more 'dead' mass not utilised in handcycle propulsion, e.g. athletes' legs, therefore body mass does not confer the same advantage during flat handcycling. Handcycling may closer relate to an uphill cycling model whereby body mass has an undesired consequence on performance. Padilla et al. [12] state that a body mass exponent of 1.00 should be used to assess uphill cycling performance which is also the value best related to race cycling performance in the ~~current~~ present study for PTWC athletes.

An acknowledged limit to this study is the single modality of laboratory tests. Although the cycling segment spans the longest duration during paratriathlon races, swim and run performance also have a great influence on overall race time. There has been little previous research regarding physiological correlates to able-bodied triathlon sprint performance in the field. Van Schuylenbergh et al. [24] did, however, attempt to assess this, albeit during a draft-legal race which will largely change the demands of cycling. The authors noted a high correlation coefficient (0.7 to 0.8) between $\dot{V}O_2$ at cycling lactate threshold and triathlon performance. Moreover, it was shown that running speed at maximum lactate steady state was also a primary performance predictor. The inclusion of swimming and running incremental tests in the present study would have permitted an analysis of additional correlates to paratriathlon race modalities beyond cycling. Moreover, capturing cycling power output during the race would have further strengthened this study. It is recognised that the race cycling time is not solely influenced by power output with wind speed and direction, temperature, air pressure, body size and position and bicycle design all effecting cycling velocity [11]. Finally, the heterogeneity in the present athlete population is noteworthy. Figures 1 and 2 highlight the level of deviation in physiological variables across PTWC and PTS paratriathletes which is exacerbated by smaller than desired sample sizes. Such variances are likely to increase the correlation coefficient between physiological variables and race cycling performance, although the coefficient of variation in race cycling time (~10%) is similar to performance measures in previous research [6]. Nonetheless, large inter-individual variance and low population numbers are an inherent facet of Paralympic athlete cohorts. The participant group studied currently are a representative sample that many coaches and practitioners may be presented within in an applied context.

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FIGURE CAPTIONS

Figure 1: PTWC paratriathletes' aerobic lactate threshold (AeLT), anaerobic lactate threshold (AnLT), onset of blood lactate accumulation (OBLA), ventilatory threshold (VT), maximal aerobic power (MAP) and peak rate of oxygen uptake ($\dot{V}O_2$peak), expressed in absolute, relative and scaled relative values, with Pearson's correlation coefficient to in-race bike time shown below. Bold values indicate a significant correlation to bike time ($p < 0.05$).

Figure 2. PTS paratriathletes' aerobic lactate threshold (AeLT), anaerobic lactate threshold (AnLT), onset of blood lactate accumulation (OBLA), ventilatory threshold (VT), maximal aerobic power (MAP) and peak rate of oxygen uptake ($\dot{V}O_2$peak), expressed in absolute, relative and scaled relative values, with Pearson's correlation coefficient to in-race bike time shown below. Bold values indicate a significant correlation to bike time ($p < 0.05$).

Table 1 Participant characteristics for PTWC and PTS paratriathletes

	PTWC (*n*=5)	PTS (*n*=10)
Age (y)	39.8 ± 4.8	31.6 ± 8.9
Body mass (kg)	66.8 ± 12.4	64.1 ± 8.4
Sex	3 male, 2 female	8 male, 2 female
Paratriathlon classification (as of 2014)	5 PT1	1 PT2, 3 PT3, 6 PT4

Table 2 Statistically significant correlation coefficients (r) between PTWC athletes' laboratory-derived variables and race cycling time including 95% confidence intervals (CI) and standard error of estimate (SEE). n=5.

	r	95% CI	SEE (s)	*p*
AeLT				
W	-0.92	-0.99, -0.20	110	0.027
$W \cdot kg^{-1}$	-0.99	-0.99, -0.99	22	<0.001
$W \cdot kg^{-0.32}$	-0.96	-0.99, -0.51	79	0.010
AnLT				
W	-0.92	-0.99, -0.20	108	0.026
$W \cdot kg^{-1}$	-0.98	-0.99. -0.72	61	0.005
$W \cdot kg^{-0.32}$	-0.97	-0.99, -0.61	67	0.006
OBLA				
W	-0.90	-0.99, -0.09	119	0.035
$W \cdot kg^{-1}$	-0.98	-0.99, -0.72	58	0.004
$W \cdot kg^{-0.32}$	-0.97	-0.99, -0.61	73	0.008
MAP				
$W \cdot kg^{-0.32}$	-0.91	-0.99, -0.14	118	0.034

AeLT = Aerobic lactate threshold. AnLT = Anaerobic lactate threshold. OBLA = Onset of blood lactate. MAP = Maximal aerobic power.

Table 3 Statistically significant correlation coefficients (r) between PTS athletes' laboratory-derived variables and race cycling time including 95% confidence intervals (CI) and standard error of estimate (SEE). n=5.

	r	95% CI	SEE (s)	*p*
AeLT				
W	-0.72	-0.93, -0.17	156	0.018
$W \cdot kg^{-0.32}$	-0.70	-0.93, -0.14	162	0.025
AnLT				
W	-0.78	-0.95, -0.30	141	0.008
$W \cdot kg^{-0.32}$	-0.78	-0.95, -0.30	142	0.008
OBLA				
W	-0.75	-0.94, -0.23	150	0.013
$W \cdot kg^{-0.32}$	-0.74	-0.93, -0.21	150	0.013
VT				
W	-0.70	-0.93, -0.14	161	0.024
$W \cdot kg^{-1}$	-0.82	-0.96, -0.40	130	0.004
$W \cdot kg^{-0.32}$	-0.74	-0.93, -0.21	153	0.015
MAP				
W	-0.88	-0.98, -0.63	109	0.001
$W \cdot kg^{-1}$	-0.88	-0.98, -0.63	107	0.001
$W \cdot kg^{-0.32}$	-0.91	-0.98, -0.69	88	<0.001
$\dot{V}O_{2peak}$				
$l \cdot min^{-1}$	-0.77	-0.93, -0.27	144	0.009
$ml \cdot kg^{-1} \cdot min^{-1}$	-0.67	-0.91, -0.07	167	0.033
$ml \cdot kg^{-0.32} \cdot min^{-1}$	-0.79	-0.95, -0.32	138	0.006

AeLT = Aerobic lactate threshold. AnLT = Anaerobic lactate threshold. OBLA = Onset of blood lactate. VT = Ventilatory threshold. MAP = Maximal aerobic power. $\dot{V}O_{2peak}$ = Peak rate of oxygen uptake.

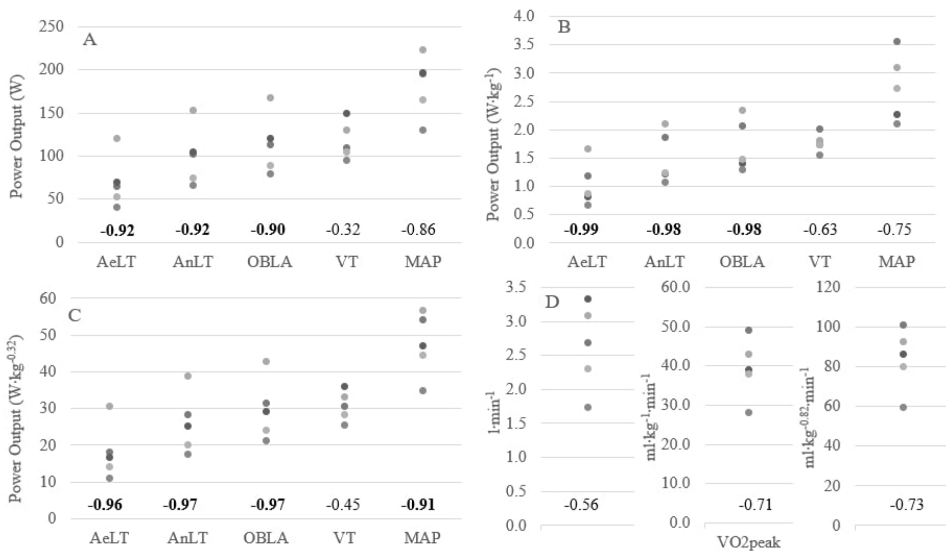

Figure 1: PTWC paratriathletes' aerobic lactate threshold (AeLT), anaerobic lactate threshold (AnLT), onset of blood lactate accumulation (OBLA), ventilatory threshold (VT), maximal aerobic power (MAP) and peak rate of oxygen uptake (VO2peak), expressed in absolute, relative and scaled relative values, with Pearson's correlation coefficient to in-race bike time shown below. Bold values indicate a significant correlation to bike time ($p < 0.05$).

337x212mm (72 x 72 DPI)

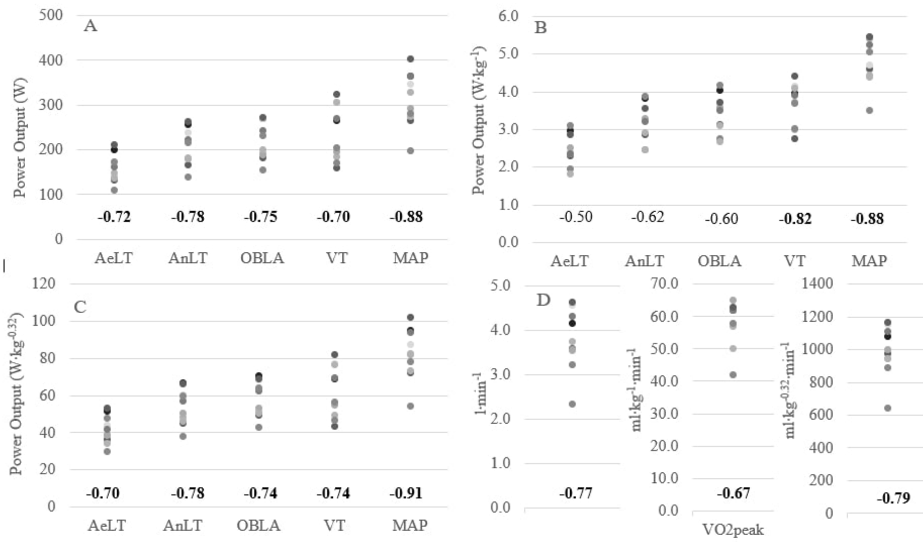

Figure 2. PTS paratriathletes' aerobic lactate threshold (AeLT), anaerobic lactate threshold (AnLT), onset of blood lactate accumulation (OBLA), ventilatory threshold (VT), maximal aerobic power (MAP) and peak rate of oxygen uptake (VO2peak), expressed in absolute, relative and scaled relative values, with Pearson's correlation coefficient to in-race bike time shown below. Bold values indicate a significant correlation to bike time ($p < 0.05$).

348x212mm (72 x 72 DPI)