FRONTAL SURFACE AREA AS A PREDICTOR OF CYCLING PERFORMANCE

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INTRODUCTION

The equation of motion of a cyclist indicates that at a constant velocity the largest morphological influence on the cyclists retarding force is the projected frontal surface area **(Kyle,1979).** Nevertheless, parameters profiling a cyclist's physical ability such as V02 max, work done in a given time or the power output achieved at the anaerobic threshold are usually normalised to body mass when making comparisons between athletes(Van Handel et al, 1988). Further, Swain et al (1987) have demonstrated that in athletes of different size riding at the same speed, athletes with greater body mass have a lower V02 to mass ratio than smaller athletes, but are similar to the smaller athletes in V02 to frontal surface area ratio. This led Swain et al (1988) to suggest that physiological parameters should be normalised to frontal surface area rather than mass. To assess the validity and usefulness of this suggestion, this study examined if cycling time trial performance could be better predicted from a physical parameter normalised to frontal surface area rather than normalised to body mass.

METHODS

A group (n=7) of male juvenile cyclists (14-16 yrs) and a group (n=11) of male junior cyclists (16-18 yrs) performed a five minute maximum effort test on a wind braked bicycle ergometer. The ergometer was fitted with a racing saddle, racing handlebars and the cyclist used his own pedals. The ergometer was fully adjustable and the cyclist's position was set to that measured from the subject's own bicycle. Following a warm-up each cyclist undertook the five minute test, starting from a stationary position and remaining seated throughout. Choice of cadence and gearing was selected by the cyclist during the test. Total work done was measured. Each cyclist's frontal surface area on the bicycle was determined by a regression equation using height and body mass (Mclean, 1993).The total work relative to body mass and the total work relative to the cyclists frontal surface area were then determined. Two days after the laboratory tests the juvenile cyclists competed in a 10 km flat time trial while the juniors competed in a 15 km flat time trial. Triathlon style aerodynamic handlebars were not used by any cyclist in either group.

The relationships between the performance parameters measured in the laboratory and the time trial performance was assessed by Pearson's correlation analysis. Probability values of $P < 0.05$ were accepted as significant.

RESULTS AND DISCUSSION

Mean data for the anthropometric variables describing both the juvenile and junior cyclists and for the performance parameters determined in the five minute ergometer test and the bicycle time trial are shown in Table 1. As expected from athletes at different stages of development, the mean data indicated that the older cyclists were larger, had greater absolute performance values in the laboratory and rode at a higher average speed during the time trial than the younger cyclists.

Table 1. **Anthropometric** and performance variables (mean ± sd)

	Juveniles (n=7)	Juniors (n=11)
Mass (kg)	61.3 ± 9.8	67.9 ± 6.7
Height (cm)	173.6 ± 8.8	177.6 ± 5.4
FSA (m2)	0.379 ± .036	0.402 ± .023
Total Work **(kj)**	92.3 ± 13.1	108.1 ± 10.7
Work/mass (kj/kg)	1.52 ± .17	1.60 ± .13
Work/FSA (kj/m2)	242.2 ± 17.4	268.8 ± 17.3
Time Trial time **(mins)**	**17.0** ± 1.12	22.49 ± 0.85

The results of the correlation analysis **(Table2)** showed that for the junior cyclists, total work correlated with time trial time and that this correlation improved when total work was normalised to body mass. The ability to predict time trial time from total work improved even further when this parameter was normalised to frontal surface area.

For the juvenile cyclists even though the correlation between time trial time and total work was marginally higher than for the juniors, this relationship was not significant. This was due to the smaller number of subjects in the juvenile group. Contrary to the result found with the junior athletes, when total work was normalised to body mass, the correlation with time trial time decreased. However, consistent with the older cyclists the work to frontal surface area ratio showed a high correlation with time trial time.

Cycling is a weight supported activity and the resistance due to body mass would be less than 10% of the total encountered when riding at the average speeds achieved in these time trials (Kyle. 1979). Consequently, it would not be expected that the work to body mass ratio would have a higher relationship with cycling performance than total work alone. The results of this study is not conclusive with regard to this parameter as the trend was different in each group. In contrast, the strong relationship between total work relative to frontal surface area and the time trial performance in both groups of cyclists supports the theoretical analysis based on the cyclist's equation of motion. Since frontal surface area is directly related to air resistance and air resistance makes up more than 90% of the total resistance at time trial speeds (Kyle, **1979),** total work relative to frontal surface area would be closely related to cycling velocity and hence time trial performance.

Table 2. Correlation of performance variables with time trial time. * **$p<0.05$**

	Juveniles (r value)	Juniors (r value)
Total Work (kj)	**-.67**	**-.65 ***
WorWmass **(kj/kg)**	**-.53**	**-.74 ***
Work/FSA (kj/m2)	**-.82 ***	**-.86 ***

CONCLUSION

These results indicate that the total work done in a laboratory ergometer test relative to the cyclist's calculated frontal surface area is a better predictor of cycling performance than total work relative to body mass or total work alone. In addition, the results indicate that this finding is consistent across athletes of different physical size and different ability. It was concluded that parameters describing a cyclist's physical ability should be normalised to frontal surface area rather than body mass when making comparisons between athletes.

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