

CHAPTER 5

DISCUSSION

Chapter 5 discusses in detail the results obtained in Chapter 4 and compares them with the results of other studies of a similar nature. Each of the factors highlighted in Chapter 4 are discussed and their contribution towards success in a triathlete is evaluated.

5.1 General Physical Characteristics

The general physical characteristics of the triathletes in this study (as seen in Table 4) namely; body mass, height, % body fat as well as the demographic characteristic of age were very similar to those previously reported for elite triathletes by O' Toole et al, 1987; Schabort, E. J. et al, 2000, Landers, G. J. et al, 2000 and Laursen, P. B. et al 2003. The triathletes in the Schabort et al study (2000) were members of the SA National Team and had just completed in the SA National Championships. The O'Toole study (1987) was made up of triathletes training for the 1984 Hawaii Ironman, comprising serious amateur and world-class professional athletes. The Laursen study (2003) was made up of eighteen highly trained male triathletes of which five had competed internationally, eight nationally and five regionally. The Millet study (2004) was made up of nine male triathletes who competed in the elite short-distance World Championships. Two were finalists (top eight ranking) at the first Olympic Triathlon in 2000. The Landers study (2000) comprised of twenty elite male triathletes that competed in the 1997 World Championships.

The mean ages of the triathletes in this study were very similar to the single sport athletes (did not differ significantly) as well as to the elite triathletes from previous studies. (See Table 12). The triathletes in the O'Toole study were older than most groups of elite swimmers, cyclists and runners previously studied probably due to the fact that triathlon racing was still a new sport and not yet a collegiate sport therefore most successful triathletes had graduated to triathlons after finishing college careers in one of the single sports. (O'Toole, M. L et al 1987).

In both long and short distance events, competition is now held between 'elite' and 'age group' athletes; elite athletes being defined as holding an ITU ranking of less than 125. Age group athletes compete against each other in five-year age categories (Bentley, D. J. et al 2002). With triathlon becoming ever more popular, athletes are electing to go straight into the sport of triathlon. This may explain why elite triathletes in this study and recent studies are younger and of similar age.

Laursen, P. B. and Rhodes, E. C (2001) describe elite triathletes as being generally tall, of average to light weight and as having low levels of body fat. The triathletes in this study tend to fit this description. The triathletes however showed no significant difference to any of the single sport athletes in this study in terms of height, body mass, % body fat and lean body mass. It is interesting to note however that in all four of these anthropometrical measurements, swimmers portrayed the highest mean values and runners the lowest. The mean body mass (kg) and lean body mass (kg) of the swimmers was significantly greater than that of runners ($P < 0.05$).

The lowest individual body mass recorded in this study was that of a runner (56,65 kg) while the highest individual body mass was that of a swimmer (92,00 kg).

Sleivert, G. G. and Rowlands, D. S. (1996), in a literature review describe male triathletes as being similar in weight (mass) to elite cyclists, but weighing less than swimmers and more than runners. Their description would concur with the findings in this study. Statistically, the mean body mass of the triathletes in this study is not significantly different to that of the runners, swimmers and cyclists however the mean body mass of triathletes is very similar to that of cyclists (71,83 kg and 72,84 kg respectively) but tends to be less than that of swimmers (77,89 kg) and greater than that of runners (64,00 kg). The mean body mass of the triathletes falls within the range of previously reported values for elite male triathletes (65 – 75 kg) as reported by Landers, G. J. et al 2000 and Schabort, E. J. 2000.

Sleivert, G. G. and Rowlands, D. S. (1996), also describe elite and sub-elite male triathletes as being similar in height to specialist cyclists and tend to be taller than specialist runners and shorter than specialist distance swimmers. Although statistically there was no difference in height between the triathletes and the single sport athletes, this tendency was observed in this study.

Although % body fat was not significantly different between the four groups of athletes, the runners were the only group in this study to have a mean % body fat of less than 10%, which fits into the range of 4% – 10% body fat for men,

as suggested by Lohman T. G. (1982) as an optimal % body fat range associated with performance, in sports where extra body fat may hinder performance (eg. endurance running). Lohman (1982) reports the mean value of % body fat for athletes to be 12%. He has reported these standards as estimates based on descriptive data from successful athletes. The body fat % of all the athletes in this study fell well below that of the mean for healthy but sedentary individuals in the general population with a reported % body fat of 15% - 16% for males. (McArdle, W.D, Katch K. I. and Katch V.I. 1991 and Lohman 1982) Lohman (1982) suggests a range of 10 – 22 % fat for men as being satisfactory for health.

The mean % body fat of the triathletes in this study is slightly higher than the range of 5% - 11,3% reported for male competitors in the 1982 Hawaii Ironman. The average % body fat value of four of the male triathletes who finished in the top fifteen was 7,1% (Holly, R. G. et al 1986). The five male triathletes in the Schabort study (2000) had a mean % body fat of 9,7%. The nine male triathletes in the Millet and Bentley study (2004) had a mean % body fat of 10,4% and the triathletes in the O'Toole study (1987) had a mean % body fat of 9,9%.

TABLE 12: Comparative Table of Physical Characteristics of Triathletes (Mean $\pm$ SD)

Reference	Age (yr)	Height (cm)	Body Mass (kg)	% Body Fat
Present Study (Zetisky, J. V., 2005) (n=12)	27,5 $\pm$ 5	179,08 $\pm$ 4,6	71,83 $\pm$ 4,9	12,22 $\pm$ 1,7
O'Toole et al, 1987 (n=14)	30,5 $\pm$ 8,8	178,8 $\pm$ 6,6	74,7 $\pm$ 10,0	9,9 $\pm$ 3,5
Schabert, E. J. et al, 2000 (n=5)	23 $\pm$ 4	181 $\pm$ 1,64	72,1 $\pm$ 4,7	9,7 $\pm$ 2,4
Millet, G. P. et al, 2004 (n=9)	24,8 $\pm$ 2,6	177,9 $\pm$ 4,8	70,2 $\pm$ 5,2	10,4 $\pm$ 2,1

The body mass and lean body mass of the swimmers in the present study is significantly greater than the body mass and lean body mass of the runners, while their height and percentage body fat (or fat mass) that they possess are similar (no significant difference). This would indicate a greater muscle mass in swimmers. As a result of their % body fat not being significantly different their % fat free mass (FFM) would also be very similar namely 90,53 % FFM for runners and 87,7% for swimmers. In absolute terms however, FFM expressed as LBM in kg is significantly different (57,72 kg vs 69,4 kg for the runners and swimmers respectively) alluding to swimmers being more muscular than runners. The somatotype rating and somatochart will illustrate the difference between the two physiques. Somatotype rating expresses relative, not absolute values.

Body composition may influence performance in swimming, cycling and running differently. In swimming, extra body fat may improve buoyancy and help reduce hydrodynamic drag. (Gullstrand, L. 1992). In contrast to swimming, where hydrodynamic drag is the greatest force to overcome

(Gullstrand, L. 1992 and Tittel, K. and Wutsherk, H. 1992), running involves the greatest weight bearing of the three disciplines within triathlon. Gravity is therefore the major force to overcome and it was not surprising that run time in a triathlon, was highly influenced by adiposity of the triathlete in the Landers, G.J. et al study (2000). As a result, excess weight would be detrimental to running performance. (Lohman, T. G. 1982). This would explain the significant difference in body mass and lean body mass between the runners and the swimmers in this study.

5.2 Somatotype Rating

Although there was no significant difference in any of the three somatotype ratings, namely endomorphic, mesomorphic and ectomorphic, between the triathletes, runners, swimmers and cyclists, there are some interesting observations to be made. In general, component ratings of 0,2 – 2,5 are regarded as low values. Ratings of 3 – 5 are regarded as mid range and ratings of 5,5 – 7 are regarded as high. Ratings higher than seven are considered extremely high. (Carter, J. E. L. and Heath, B. H. 1990).

The triathletes as well as the single sport athletes all portray a low rating of endomorphy. A low rating of endomorphy describes a markedly lean physique with a minimum of subcutaneous fat or little relative fatness. Carter, J. E. L. (1970) in a review of the somatotypes of athletes reports that almost all groups of championship athletes are rated high on mesomorphy but the least mesomorphic among the athletes are distance runners. The

mesomorphy ratings of the athletes in the present study fit Carter's description, with all the athletes portraying a mesomorphy rating regarded as mid-range with runners being the least mesomorphic among the athletes. The triathletes, swimmers and cyclists have a mean mesomorphy rating of 3,8; 3,9 and 4 respectively compared with the runners' rating of 3,1. High ratings in mesomorphy signify large muscle mass with wide range bone diameters relative to stature.

The ectomorphy ratings of the athletes in this study show runners as having the highest mean value and swimmers the lowest, namely 3,5 and 2,7 respectively. The runners fall into the mid-range category of ectomorphy and the swimmers into the low-range category. The triathletes and the cyclists, having the same ectomorphy rating of 2,8 fall between the runners and the swimmers. According to the review by Carter (1970), ectomorphy usually shows the most variability within most sports, with distance runners rating the highest. The same is evident in the present study. Low ratings in ectomorphy denote physiques with great mass relative to stature and high ratings denote physiques with little mass relative to stature and elongated limb segments. (Carter, J. E. L. and Heath, B. H. 1990).

According to the thirteen categories of somatotype classification as defined by Carter, J. E. L. and Heath, B. H. (1990), the mean somatotype of the triathletes, cyclists and swimmers in this study would be classified as ectomorphic-mesomorph with mesomorphy being dominant and ectomorphy being greater than endomorphy (by more than one half-unit). The runners

would be classified as mesomorphic-ectomorph (with ectomorphy being dominant and mesomorphy greater than endomorphy). The somatotype of the distance runner is characterised by high ectomorphy and relatively low endomorphy and mesomorphy (Berg, K et al 1998).

Carter and Heath (1990) report the means for top class swimmers from the 1960's to the 1980's as centred around the 2,5 – 5 – 3 somatotype. Siders, W. A. (1993) et al report somatotype ratings of 2,3 – 3,8 – 2,8 in a study on competitive collegiate swimmers. Coetzee, B. (2002), reported mean somatotype ratings of male South African freestyle (crawl) swimmers finishing in the top ten places at the S.A. Swimming Championships as being 2,2 – 4,4 – 3,3. Coetzee concluded that the swimmers in his study were classified as ectomorphic-mesomorph. In the above-mentioned studies, as well as with swimmers in the present study, the dominant feature is mesomorphy.

Landers, G. J. et al (1999) compiled a somatotype rating of 20 senior male triathletes at the 1997 Triathlon World Championships, eight of whom finished in the top 20. Their mean endomorphy, mesomorphy and ectomorphy ratings were 1.9 – 4.2 – 3.0 respectively classifying them as ectomorphic – mesomorph. The triathletes in this study (2.0 – 3.8 – 2.8) fall into the same somatotype category as those at the 1997 World Championships.

5.3 Aerobic Capacity

The aerobic capacity (VO_{2max}) of the triathletes is not significantly different from that of the single sport athletes, measured in $mlO_2 \cdot kg \cdot min^{-1}$. The VO_{2max} .

of triathletes has been reported to be competitive with those of elite swimmers, cyclists and runners (O'Toole, M. L. 1987 and O'Toole, M. L. 1995). This is also evident in the present study. Since the triathletes studied by O'Toole (1987) trained less in any one sport than did elite single sport athletes, the achievement of competitive VO_{2max} values may suggest a true cross-training effect. The VO_{2max} of the triathletes in this study ($62,59 \pm 3,9 \text{ ml.kg.min}^{-1}$) is comparable with the suggested minimum 65ml.kg.min^{-1} value necessary for successful performance in a triathlon. (Bunc, V, Heller, J 1996). The athletes in this study were tested in Johannesburg that lies on a high altitude inland plateau of about 1800m above sea level. There is substantial evidence that suggests that aerobic capacity is substantially lower at higher altitudes. In a study by Roi, G. S. et al (1999) comparing the effects of altitude on marathon performance, VO_{2max} significantly decreased with altitude. Running speed decreased by 35% at 4,300m altitude (Everest Marathon). Elite runners used a much greater proportion of VO_{2max} at this altitude than lesser performers. Running economy at altitude was also adversely affected (lowered) because of the higher mechanical work of breathing. For example, at an altitude of 2300m (Mexico City) the reduction in oxygen transport during maximal exercise is in the order of 15%. (Astrand, P.O. and Rodahl, K. 1986). Margaritis, I. (1996) concurs that a minimum level of maximal oxygen uptake is required but that this does not always determine the performance of triathletes.

VO_{2max} of triathletes has been reported to range from $61 - 85\text{ml.kg.min}^{-1}$ during treadmill running. (Noakes, T. D. et al 1985; Holly, R. G. et al 1986;

O'Toole, M.L. 1987). The triathletes in this study fall within this range even though our measurements were made at an altitude of 1800m.

The VO_{2max} of runners ($64,51\text{ml.kg.min}^{-1}$) however, is significantly higher than that of swimmers ($57,13\text{ml/kg.min}$) in the present study ($P<0,05$). The VO_{2max} of the runners was the highest of the four groups while the swimmers were the lowest. The VO_{2max} of the triathletes and cyclists were almost identical and fell between that of the runners and swimmers. The swimmers were the only group to have a VO_{2max} below 60ml.kg.min^{-1} .

Highly trained male swimmers have been reported to have VO_{2max} values ranging from $50 - 75\text{ml.kg.min}^{-1}$ (Costill, D. L. 1992). The swimmers in this study fall within this range. Although it constitutes an important physiological factor, VO_{2max} is only one of the parameters explaining successful performance. One of the factors considered in explaining how high performance may be achieved with a relatively low VO_{2max} include the capacity to use a high percentage of VO_{2max} over extended periods of time (Di Prampero, P. E. 1986) as well as the ability to minimise energy expenditure at a given sub-maximal work load (Conley, D. et al 1980; Morgan, D. W. et al 1991).

In Kohrt's study (1987) swim performance was not significantly related to swimming VO_{2max} , therefore stroke mechanics (skill / technique) and efficiency are presumably a more important determinant of performance. Therefore, improving the mechanical aspects of swimming may be equally, if not more important than improving strength and endurance. (Costill, D. L.

1992; Toussaint, H. M. 1990). This may explain the relatively low VO_{2max} of swimmers in the present study. It has been suggested that the VO_{2max} of swimmers should not be expressed in $ml.kg.min^{-1}$, since less work is needed to support the body weight in water and the weight consequently does not constitute nearly as important a loading factor as in running. The most useful measure of aerobic performance in swimmers at present is the swimmer's VO_{2max} expressed in litres per minute ($l.min^{-1}$). (Holmér, I. 1974).

For comparative purposes in this study however, we did not differentiate aerobic capacity in terms of weight bearing exercise (eg. running), minimal weight bearing exercise (eg. swimming), and partial weight bearing exercise (eg. cycling depending on the gradient of the cycling terrain. Cycling downhill or level as opposed to uphill in which weight bearing increases depending on the slope). For uniformity, VO_{2max} in this study was therefore expressed in $ml/kg.min$ because triathletes participate sequentially in each discipline (weight bearing, minimal weight bearing and partial weight bearing). This weight corrected expression of aerobic capacity ($ml.kg.min^{-1}$), has been used by other authors for all three events. (Kohrt, W. M. 1987; O'Toole, M. L. 1987; O'Toole, M. L. 1995; Schabort, E. J. 2000; Sleivert, G. G. 1996)

In a previous study, where elite marathon runners were defined as athletes with personal records below 2h30min, VO_{2max} was reported to be $74,2ml.kg.min^{-1}$ (Svendenhag, J. and Sjodin, B. 1984). The mean value of VO_{2max} of cyclists in the U.S. National Team in 1980 were reported to be $74ml.kg.min^{-1}$ (Burke, E. R. 1980) The runners and cyclists in the present

study, although falling within the accepted range of successful endurance athletes, had mean $\text{VO}_{2\text{max}}$ values approximately 14% lower than those mentioned above probably once again, as a result of being tested at high altitude.

5.4 Running Economy

There was no significant difference in running economy between the four groups of athletes despite the fact that running economy for all the athletes was tested on a treadmill, which will have put swimmers and cyclists at a disadvantage. The results however indicate that highly trained endurance athletes have the ability to exercise at a lower percentage of $\text{VO}_{2\text{max}}$ for prolonged periods of time, at a given sub-maximal workload and by so doing minimise their energy expenditure.

Although not significantly different, runners tended to display the most favourable running economy ($184,9 \pm 13,86 \text{ mlO}_2.\text{kg}.\text{km}^{-1}$) and swimmers the least favourable ($210,85 \pm 13,41 \text{ mlO}_2.\text{kg}.\text{km}^{-1}$). Elite swimmers in particular are characterised by their favourable economy of movement during swimming and it has been reported in the literature that single sport swimmers have better movement economy ie. lower energy cost and higher propelling efficiency than triathletes (O'Toole, M. L. et al 1995; Toussaint H.M. 1990; Chatard, J. C. et al 1995; Sleivert, G.G. et al 1996). It has been suggested that economy of effort is related to triathlon performance. (Sleivert, G. G. et al 1996).

5.5 Muscle Strength and Endurance

In the isokinetic test of muscle strength and endurance, the triathletes showed no significant differences to any of the single sport athletes at 60°/s, 160°/s or at 245°/s for knee and shoulder flexion and extension. There was however one significant difference, that being between cyclists and swimmers. The cyclist knee extension torque to body weight ratio (Nm.kg^{-1}) at 60°/s ($3,98\text{Nm.kg}^{-1}$) was significantly greater than that of swimmers ($3,19\text{ Nm.kg}^{-1}$). This could possibly indicate that cyclists have significantly greater quadriceps muscle strength per kg body weight than do swimmers, ie. they are able to generate greater quadriceps force /kg body weight. The ready availability of brief but high intensity, anaerobic energy reserves is exploited in the FT muscle fibres of the cyclist while 'jumping' to stay with the pack and during the final sprint (Ryschon, T. W. 1994). Ryschon reports that the muscles used in cycling are a mixture of ST and FT fibres. In all endurance sport, high performance is associated with the ability to sustain work rates at a high $\text{VO}_{2\text{max}}$. The number of years a cyclists has competed and a high percentage of type I muscle fibres (quadriceps) are two factors associated with the ability to perform sustained cycling at a high percentage $\text{VO}_{2\text{max}}$. (Coyle, E. F. et al 1988).