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PHYSIOLOGICAL FACTORS ASSOCIATED WITH SUCCESSFUL COMRADES ATHLETES

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DEDICATION

This dissertation is dedicated to my husband Armand.

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SYNOPSIS

TITLE:	Physiological factors associated with successful Comrades Athletes
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Many scientific investigations have consistently identified the physiological variables that are positively related to successful endurance performance (Hawley, 1995). The extent to which these and other factors are "trainable" as opposed to genetically determined is a topic of considerable debate (Bouchard et al., 1992). Maximal oxygen uptake is the most common parameter used in exercise laboratories to estimate physical fitness. Costill et al. (1973) noted that subjects with similar VO_2 max values often performed quite differently in endurance events. To evaluate physical fitness more precisely, another parameter, reflection endurance capacity, should be determined in addition to VO_2 max (Vago et al., 1987).

Sport Science can play an important role in the success of ultra marathons by helping the athletes to achieve their optimal fitness levels. Science has given us a unique insight into the anatomy of one of the most difficult races in the world.

The purpose of the study was to assess experimentally the physiological status of a Comrades Marathon athlete and to examine the effect of training on the physiological parameters. The major objectives of the study were:

- to identify the physiological factors associated with successful endurance performance;
- to measure the effect of training on the VO_2 parameters on a regular basis;
- to provide training guidelines;

- to use heart rate monitors to guide training and optimise race performance; and
- to measure heart rate response during the Comrades Marathon race, thus to determine race intensity.

Five male marathon athletes volunteered to take part in the study. All the subjects were training for the 1998 Comrades Marathon and all of them had run the Comrades before. They had been following a training programme for a minimum of four years and were experienced treadmill runners. The first testing occurred eight months before the Comrades; thereafter, another five tests were undertaken. Their regular training regiments included weekly distances of at least 80 km, with workouts of moderate to high intensity. The day before each test, no intensive training was allowed.

Following an anthropometric evaluation, a maximal incremental treadmill test was undertaken to ascertain the VO_2 max and endurance fitness of the athletes. After a progressive warm-up phase, starting at a speed of 10 km/h, the speed was increased by 2 km/h every three minutes, until a speed of 16 km/h was reached. The treadmill speed was then increased by 1 km/h every two minutes until exhaustion. Blood lactate samples were collected during the test, at the end of each workload.

The physiological parameters measured were oxygen consumption (VO_2 max), maximal heart rate (HR), lactate threshold, ventilatory threshold, respiratory exchange ratio (R), and oxygen pulse. Each subject's best running times for the 10, 21, 42, 50, 56 and 90km had been recorded during the previous year. Training distances were also recorded during the testing period. Each subject ran the Comrades Marathon with a Polar Vantage NV to determine race intensity, heart rate response during the race, percentage below the lactate threshold and percentage above the lactate threshold.

The results indicated statistically that some of the VO_2 max parameters change during the eight months time period. It has been found however, that some of the maximum parameters did not change to a great extent (VE/VO_2 = 0.01%, VO_2/HR = 1.3%, VO_2 max = 3.54%, VO_2 absolute = 0.98%, RQ = 0.58%, VT = 4.31%, VE = 0.73%), speed and heart rate showed a decrease at the maximal exercise intensity (speed = -4.94%, heart rate = -4.37%). There was a

greater improvement at parameters measured at threshold level (VE/VO_2 = 1.45%, VO_2/HR = 5.43%, VO_2 max = 5.73%, VO_2 absolute = 6.62%, RQ = 1.70%, VT = 4.19%, VE = 7.78%, speed = 9.10% and heart rate = 6.34%).

Relationship between the lactate threshold and the actual heart rate response indicated that none of the athletes could complete a 90km race at the lactate threshold intensity. It has been found that the athletes could only keep their heart rate above a certain percentage of the lactate threshold during the duration of the race (30.3% above 95% of the lactate threshold, 58.3% above 90% of the lactate threshold and 77.3% above 85% of the lactate threshold).

The anthropometric data did not change much during the training months. The most substantial change could be seen in the fat percentage of the athletes (2.45% decrease). All of the athletes do however, showed a decrease in LBM (3.37%)

In conclusion it has been found that the athletes were not able to keep up with the heart rate just below the lactate threshold during the Comrades Marathon. As a result of worsened running economy, especially during the last 20km, none of the athletes could complete the race between 2-4-mmol/L lactate. It seems that more interval training and gymnasium work would be necessary to build enough of the stamina endurance that is an important parameter for Comrades athletes. Laboratory testing can help the athlete to optimise his running potential. Parameters of importance are an improvement at lactate threshold intensity and not at maximum intensity because those parameters simulate the race intensity.

LIST OF KEY WORDS:

COMRADES MARATHON, HEARTRATE RESPONSE, LACTATE THRESHOLD, VENTILATORY THRESHOLD, VO_2 max, RUNNING ECONOMY, AEROBIC EXERCISE, FATIGUE, RESPIRATORY EXCHANGE RATIO, VENTILATORY EQUIVALENT, VELOCITY.

SINOPSIS

TITEL:	Fisiologiese faktore wat met suksesvolle Comrades Marathon atlete geassosieer word
KANDIDAAT:	E Heydenrych
STUDIELEIER:	Prof. P.E. Krüger
GRAAD:	MA(MBK)

Sportwetenskaplikes bestudeer gereeld die fisiologiese veranderlikes wat geassosieer word met uithouvermoë prestasie (Hawley, 1995). Die mate waarin die veranderlikes ingeoefen kan word in teenstelling met genetiese bepaling is 'n onderwerp van debat (Bouchard et al., 1992). Maksimale suurstofverbruik is die algemeenste parameter wat in laboratoriums gebruik word om fisieke fiksheid te bepaal. Costill et al. (1973) het gemerk dat persone met dieselfde VO_2 maks waardes, verskillend presteer in uithouvermoë items. Om fisieke fiksheid meer presies te meet moet ander parameters wat aerobiese kapasiteit weerspieël, bepaal word tot aanvulling van VO_2 maks (Vago et al., 1987).

Sportwetenskap speel 'n belangrike rol in die sukses van ultra maratons om die atlete te help om hulle optimale fiksheidsvlakke te kan bereik. Wetenskap gee 'n unieke insig in die anatomie van een van die moeilikste wedlope in die wêreld naamlik die Comrades Marathon.

Die doel van die studie is om eksperimenteel die fisiologiese status van Comrades Marathon atlete te bepaal asook die effek van oefening op die fisiologiese parameters. Die hoof doelwitte was:

- om die fisiologiese faktore te identifiseer wat geassosieer word met uithouvermoë prestasie;
- die effek van oefening op die VO_2 parameters te bepaal op 'n gereelde basis;

- om oefen riglyne te voorsien;
- om hartmonitors te gebruik as 'n riglyn vir oefening asook om prestasie te optimaliseer; en
- om harttempo respons tydens die Comrades Marathon te meet, dus om wedloop intensiteit te bepaal.

Vyf marathon mans atlete het vrywilliglik aangebied om aan die studie deel te neem. Al die atlete het geoefen vir die 1998 Comrades Marathon en almal het voorheen al aan die Comrades deelgeneem. Al vyf atlete volg reeds 'n oefenprogram die afgelope vier jaar, en almal het al op 'n trapmeul gehardloop. Die eerste toetse het agt maande voor die Comrades plaasgevind; daarna is nog vyf toetse gedoen. Atlete se oefenprogram sluit afstande van ten minste 80 km per week in, teen hoë en gemiddelde intensiteite. Die dag voor die toetse was geen intensiewe oefeninge toegelaat nie.

Na die antropometriese evaluasie is 'n maksimale VO_2 maks toets uitgevoer om aerobiese potensiaal te bepaal. Na 'n progressiewe opwarmingsfase is die toets teen 10 km/hr begin. Elke las duur 3 minute waarna die spoed met 2 km/hr vermeerder word tot 16 km/hr bereik is. Daarna is die spoed met 1 km/hr verhoog elke 2 minute tot totale uitputting. Bloed laktaat monsters is geneem na elke inkrement en aan die einde van die toets.

Die fisiologiese parameters bepaal sluit maksimale suurstofverbruik (VO_2 maks), maksimale harttempo (HT), laktaat draaipunt, ventilatoriese draaipunt, respiratoriese kwosiënt (RK), en suurstof pols in. Beste 10, 21, 42, 50, 56 and 90km hardloop tye gedurende die laaste jaar bereik is genotuleer. Oefen afstande is ook weergegee tydens die toets periode. Al die atlete het die Comrades Marathon met 'n Polar Vantage NV voltooi om die intensiteit en harttempo respons gedurende die wedloop te bepaal asook persentasie bo en onder die laktaat draaipunt.

Die resultate het statisties aangetoon dat van die VO_2 maks parameters verander het gedurende die agt maande oefenperiode. Daar het egter in sommige van die parameters nie groot veranderinge plaasgevind nie (VE/VO_2 = 0.01%, VO_2/HT = 1.3%, VO_2 maks = 3.54%, VO_2 absoluut = 0.98%, RK = 0.58%, VT = 4.31%, VE = 0.73%), spoed en harttempo het beide 'n afname getoon tydens maksimale inspanning (spoed = -4.94%, harttempo = -4.37%). Daar was egter 'n groter verbetering by die parameters wat tydens laktaat draaipunt gemeet is

(VE/VO_2 = 1.45%, VO_2/HR = 5.43%, VO_2 maks = 5.73%, VO_2 absoluut = 6.62%, RK = 1.70%, VT = 4.19%, VE = 7.78%, spoed = 9.10% and harttempo = 6.34%).

Harttempo respons tydens the wedloop het aangedui dat nie een van die atlete die Comrades Marathon teen laktaat draaipunt intensiteit kon voltooi nie. Die atlete kon slegs 'n sekere persentasie van die laktaat draaipunt harttempo handhaaf gedurende die wedloop (30.3% bo 95%van die laktaat draaipunt, 58.3% bo 90% van die laktaat draaipunt 77.3% bo 85% van die laktaat draaipunt).

Die antropometriese metinge het nie baie verander gedurende die oefen maande nie. Grootste veranderinge is aangetoon in die vet persentasie (2.45% afname). Al die atlete het egter 'n afname in vetvrye massa aangetoon (3.37%).

Opsommend is gevind dat die atlete nie in staat was om hulle harttempo's net onder die laktaat draaipunt te handhaaf gedurende die Comrades Marathon nie. As gevolg van verswakte hardloopekonomie, veral gedurende die laaste 20 km, kon nie een van die atlete die wedloop tussen die 2-4 mmol/L intensiteit handhaaf nie. Dit blyk asof meer gimnasium werk en interval oefening nodig is om stamina en spieruithouvermoë te verhoog wat 'n belangrike parameter is vir Comrades atlete. Laboratorium toetse kan die atleet help om sy hardloop potensiaal te optimaliseer. Parameters van belang is verbetering in laktaat intensiteit en nie noodwendig teen maksimale intensiteit nie, omdat dit die wedloop intensiteit simuleer.

LYS VAN SLEUTELWOORDE:
COMRADES MARATHON, HARTTEMPO RESPONS, LAKTAAT DRAAIPUNT, VENTILATORIESE DRAAIPUNT, VO_2 maks, HARDLOOPEKONOMIE, AEROBIESE OEFENING, UITPUTTING, RESPIRATORIESE KWOSIëNT, VENTILATORIESE, SPOED.

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