CASE REPORT

Heart rate response to ultraendurance cycling

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The heart rate (HR) response to ultraendurance cycling is poorly understood. This case report describes the exercise intensity of ultraendurance cycling by means of HR monitoring in a well trained male amateur cyclist performing the Ötztal Radmarathon twice en bloque in a circuit of two identical laps (distance 460 km; cumulative altitude difference 11 000 m). The overall intensity was moderate (HR_{mean} = 130 beats/min; HR_{mean}/HR_{max} = 0.71) corresponding to an average individual workload of 47% of VO_2MAX. Almost the whole race was performed under aerobic conditions (99.6%); high intensity work was negligible (0.4%). The average speed and the HR response also declined in the course of the two laps, average speed by 17.2% (23.8 to 19.7 km/h), HR_{mean} by 10.1% (138 to 124 beats/min), and HR_{mean}/HR_{max} by 10.7% (0.75 to 0.67). This scale of HR decrease corresponds to comparable data gained in the field of triathlon and represents a specific cardiac feature of ultraendurance exercise in general.

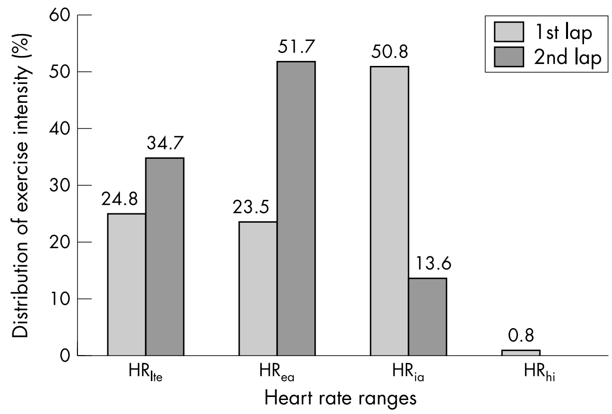

Figure 1 Comparison of heart rate (HR) response between the two laps of the ultraendurance event. HR_{lte}, long term endurance HR (<119 beats/min); HR_{ea}, extensive aerobic HR (119–145 beats/min); HR_{ia} , intense aerobic HR (145–171 beats/min); HR_{hi}, high intensity HR (>171 beats/min).

The available information about man's physiological heart rate (HR) response to long term cycling is restricted to data obtained from professional road cycling[1–4] and from cycle touring events of the usual distance.[5] Respective experience on the exercise intensity of ultraendurance cycling is sparse. With the increasing popularity of ever more gruelling ultraendurance racing events, clarification of the exercise intensity involved is important. The intensity of a specific exercise can be estimated from the HR response.[6 7] The purpose of this case report is to describe the HR response of a well trained amateur athlete who performed the Ötztal Radmarathon twice en bloque in a circuit of two identical laps.

The Ötztal Radmarathon is a very challenging one day cycle race held annually in the Alps of the Tyrol. Its double workload is characterised by a distance of 460 km and a cumulative altitude difference of 11 000 m. HR was recorded during the whole marathon by the use of a Polar Vantage NV telemeter (Polar Electro, Oy, Finland). The recorded data were analysed by using a computer program (Polar Heart Rate Analysis Software 5.03; Polar Electro) that allows the selection of three reference HRs and the establishment of four levels of exercise intensity. The reference HRs were derived from a maximal exercise test before the race and were calculated from the "Karvonen formula" by multiplying the heart rate reserve (HRR; HRR = HR_{max}–HR_{rest}) by the factors 0.5, 0.7, and 0.9 and adding these values to the HR at rest (HR_{rest}).[8] The following HR ranges were defined: long term endurance range (HR_{lte}), <119 beats/min (<50% HRR); extensive aerobic range (HR_{ea}), 119–145 beats/min (50–70% HRR); intensive aerobic range (HR_{ia}), 145–171 beats/min (70–90% HRR); high intensity range (HR_{hi}), >171 beats/min (>90% HRR).[6 7]

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The 36 year old athlete was 1.78 m tall, and his body mass and body mass index were 70 kg and 22 kg/m^2 respectively. His training in 1999 amounted to 12 000 km. The race time was 20 h 51 min, and the lap times were 9 h 40 min and 11 h 11 min. During the event, his energy intake—consisting of solutions rich in carbohydrates, noodles, cake, and such like—was about 41 MJ. Despite fluid replacement of 8 litres, he lost 3 kg during the race, which he regained in the following 24 hours. In

Table 1 Lap characteristics and exercise intensity of the ultraendurance event

	Whole race	1st lap	2nd lap
Race time	20 h 51 min	9 h 40 min	11 h 11 min
Average speed (km/h)	22	23.8	19.7
HR_{mean} (beats/min)	131	138	124
$\%HR_{max}$	0.71	0.75	0.67
HR_{lte} (<119 beats/min)	30.1 (6 h 17 min)	24.8 (2 h 24 min)	34.7 (3 h 53 min)
HR_{ea} (119-145 beats/min)	38.6 (8 h 3 min)	23.5 (2 h 16 min)	51.7 (5 h 47 min)
HR_{ia} (145-171 beats/min)	30.9 (6 h 26 min)	50.8 (4 h 55 min)	13.6 (1 h 31 min)
HR_{hi} (>171 beats/min)	0.4 (5 min)	0.9 (5 min)	0.0

HR, Heart rate; HR_{lte}, long term endurance range; HR_{ea}, extensive aerobic range; HR_{ia}, intensive aerobic range; HR_{hi}, high intensity range.

the laboratory examination before the race, the athlete's HR_{rest} and HR_{max} were 54 and 184 beats/min, and his maximal power output (W_{max}) was 400 W (= 5.7 W/kg) with 352 W (5.0 W/kg) at the onset of blood lactate accumulation.

The exercise intensity of the event was moderate. Almost all the exercise (99.6%) was performed under aerobic conditions (HR_{lte} + HR_{ea} + HR_{ia} = 20 h 46 min). High intensity work (0.4%) was negligible (HR_{hi} = 5 min). HR_{lte} was mainly measured during the downhill section of the passes, HR_{ea} during the flat sections of the course, and the more intensive HR values (HR_{ia} + HR_{hi}) exclusively during the long mountain ascents. During the race, an appreciable shift towards lower HR was observed. HR_{mean} was 138 and 124 beats/min in the 1st and 2nd lap respectively. The calculated HR_{mean}/HR_{max} ratios were 0.75 and 0.67 respectively. Consequently HR_{mean} declined by 10.1%, and HR_{mean}/HR_{max} ratio by 10.7% in the course of the two laps. A detailed description of the HR response and a subanalysis of the two identical laps is given in table 1 and illustrated in fig 1.

DISCUSSION

In a previous study,[5] we found a mean $HR_{average}/HR_{max}$ of 0.77 in recreational athletes participating in a cycle touring event. The somewhat reduced $HR_{average}/HR_{max}$ (0.71) found in this athlete can be explained by the unusually long duration of the event. The energy requirements of long term exercise need greater contribution from fat and protein stores.[9] Subsequently, this decreases intensity as fat oxidation reduces the availability of ATP relative to the oxidation of carbohydrates.[10]

Research has just begun to investigate the physiological effects of ultraendurance exercise.[9–11] This case report contributes further to the understanding of HR response and exercise intensity of ultraendurance events.

Take home message

The exercise intensity of ultraendurance cycling is moderate. A pronounced decline in the HR response is a specific cardiac feature of ultraendurance exercise.

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REFERENCES

1 **Fernandez-Garcia B**, Perez-Landaluce J, Rodriguez-Alonso M, *et al*. Intensity of exercise during road race pro-cycling competition. *Med Sci Sports Exerc* 2000;**32**:1002–6.
2 **Lucia A**, Hoyos J, Carvajal A, *et al*. Heart rate response to professional road cycling: the Tour de France. *Int J Sports Med* 1999;**20**:167–72.
3 **Padilla S**, Mujika I, Orbananos J, *et al*. Exercise intensity during competition time trials in professional road cycling. *Med Sci Sports Exerc* 2000;**32**:850–6.
4 **Padilla S**, Mujika I, Orbananos J, *et al*. Exercise intensity and load during mass-start stage races in professional road cycling. *Med Sci Sports Exerc* 2001;**33**:796–802.
5 **Neumayr G**, Pfister R, Mitterbauer G, *et al*. Exercise intensity of cycle-touring events. *Int J Sports Med* 2002;in press.
6 **Gilman MB**. The use of heart rate to monitor the intensity of endurance training. *Sports Med* 1996;**21**:73–9.
7 **Gilman MB**, Wells CL. The use of heart rates to monitor exercise intensity in relation to metabolic variables. *Int J Sports Med* 1993;**14**:339–44.
8 **Karvonen MJ**, Kentala E, Mustala O. The effects of training on heart rates. A "longitudinal" study. *Ann Med Exp Biol Fenn* 1957;**35**:307–10.
9 **Kreider RB**. Physiological considerations of ultraendurance performance. *International Journal of Sports Nutrition* 1991;**1**:3–27.
10 **Laursen PB**, Rhodes EC. Factors affecting performance in an ultraendurance triathlon. *Sports Med* 2001;**31**:195–209.
11 **O'Toole ML**, Douglas PS, Hiller WD. Use of heart rate monitors by endurance athletes: lessons from triathletes. *J Sports Med Phys Fitness* 1998;**38**:181–7.