Rest in underperforming elite competitors

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This study examines the effects of 3–5 weeks of physical rest on selected physical, physiological and psychological parameters obtained from 12 Olympic but latterly underperforming competitors and their matched control subjects. Cardiorespiratory data were directly determined from their work to volitional exhaustion on either a treadmill, cycle, or rowing ergometer. Anaerobic power and capacity were evaluated through modified Wingate tests. For psychometric assessments, the Profile of Mood States (POMS) was used.

For the Olympic competitors, one-way analyses of variance (ANOVA) revealed significant increases ($p < 0.05$) in body weight, maximum respiratory exchange ratio, maximum oxygen consumption, and heart rate at the anaerobic threshold, following the rest period. There was also a significant reduction in fatigue and mood profile score, and a significant increase in vigour. No significant changes were found in the matched control subjects. The present data show that resting for 3–5 weeks assists underperforming elite competitors to improve their aerobic performance.

Keywords: Underperformance, chronic fatigue, elite competitors, cardiorespiratory and anaerobic data, POMS, physical rest

Introduction

Despite the fact that physical training may improve sports performance, increased amounts in either training volume or intensity may excessively overload the physiological mechanisms of adaptation. As a result, competitors may report a feeling of constant fatigue^{1,2}, an inability to perform well during both training and competition³, an inability to recover optimally following competition, a loss in competitive desire, and a loss in enthusiasm for training⁴.

Symptoms and signs vary from person to person. Those often associated with athletic fatigue and underperformance are feelings of exhaustion, sleeplessness, frequent upper respiratory tract infections, weight loss, raised resting lactate concentrations, cardiovascular changes^{4–7}, and lower maximal physical working capacity⁸. Elevations of serum cortisol, creatine kinase (CK), lactate dehydrogenase (LDH),

and serum glutamic oxalic transaminase (SGOT), appear to be normal responses to the stress of an increased training load^{9,10}.

There are also well recognized behavioural changes associated with underperformance. Depression, for example, seems to be present among individuals suffering from chronic fatigue¹¹, and in swimmers who experience staleness¹². Significant increases in depression, anger, fatigue, and the composite measure of mood (i.e. mood profile) have been measured in swimmers following elevations of training volumes⁶. Links between emotions and, for example, the immune system, have also been postulated¹³. Thus, a multidisciplinary approach which includes psychometric assessments has been recommended for research related to conditions of fatigue¹⁴.

Unfortunately, the main causes for this condition, usually referred to as 'the overtraining syndrome', 'staleness' or 'burnout' are not clear. However, it has been speculated that changes in both physical activity and nutrition may influence immune function by decreasing the phagocytic function of monocytes¹⁵. It has been further reported that the observed fatigue may be due to impairment of central rather than peripheral mechanisms¹⁶.

Although periods of rest from training and competition may result in a drop in the incidence of infectious illness¹⁷ and in a decline of fitness levels¹⁸, the contribution of rest to underperforming elite competitors is not clear². Therefore, the purpose of this study was to examine the effects of rest on selected physical, physiological and psychological parameters in competitors suffering from fatigue and unexplained underperformance.

Methods

Subjects

Twelve underperforming Olympic competitors (mean age = 25 years; mean height = 184.2 cm) from five different sports (middle-distance running, rowing, cycling, swimming and race-walking) were tested at the British Olympic Medical Centre during periods of underperformance and chronic fatigue seemingly the result of increased training loads. These subjects were re-rested following 3–5 weeks of physical rest in which all competitive and training stress was eliminated. Twelve elite athletes matched for event acted as controls (mean age = 24.5 years; mean height = 178 cm). They continued with their normal training and competition.

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Physiological assessments

Cardiorespiratory data were determined directly by work to volitional exhaustion on an appropriate ergometer, either treadmill, or cycle or rowing ergometer. The test protocol consisted of 5 minutes of steady-state work, followed by progressive 1 minute increments to exhaustion. Maximum oxygen uptake ($\dot{V}O_2$ max), $\dot{V}CO_2$ production, respiratory exchange ratio ($R = \dot{V}CO_2/\dot{V}O_2$), and ventilation ($\dot{V}_E$), were among the breathing parameters determined using the open circuit method. The anaerobic threshold (AT) was determined for each subject using the definitions of the work rate or time just before (1) the departure from linearity of the ventilatory response to incremental exercise, and/or (2) a systematic increase in the ventilatory equivalent of oxygen ($\dot{V}_E/\dot{V}O_2$) without an increase in the ventilatory equivalent for carbon dioxide ($\dot{V}_E/\dot{V}CO_2$)¹⁹.

An automated gas analyser (Jaeger Sprint) was used to record respiratory parameters every 30 seconds during testing while subjects inspired room air through a low-resistance two-way Rudolph valve. The gas analysers were calibrated with standard gases. Spot checks were made on the calibration of the pneumotachygraph for volume flows up to 100 litres per minute using a 1-litre syringe. Heart rates were also monitored during ergometry. Finally, anaerobic power and capacity were evaluated over a 30 second supramaximal effort, by using modified Wingate tests for both upper and lower body²⁰.

Psychometric assessment

The Profile of Mood States (POMS) self-administered personality questionnaire was used in this study. The POMS uses 65 adjectives factored into six clearly defined transitory mood dimensions of tension-anxiety (T), depression-dejection (D), anger-hostility (A), vigour-activity (V), fatigue-inertia (F) and confusion-bewilderment (C). Each mood dimension is rated on a five point scale (i.e. from 'not at all' to 'extremely'). To obtain a score for each mood factor, the sum of the responses is calculated for the adjectives defining the factor. A mood profile or a total mood disturbance score may be obtained by summing the scores for the six primary mood states, with 'vigour' weighted negatively, on the six primary mood factors. For the purposes of this study, a constant of 100 was added to the composite POMS scores in order to avoid negative values. There are four response sets that can be employed with the POMS. The 'How you have been feeling during the past week including today?' was used for the purposes of the present study.

Despite certain limitations²¹, the POMS was selected for the purposes of this study because of its reliability and validity^{22,23}, ease of administration, and frequent use in related studies^{6,12}.

Application of the POMS has revealed that elite male endurance runners exhibit lower tension, depression, anger, fatigue, and confusion, and higher vigour than elite female runners²³ and that female runners score lower in all six states compared

Table 1. Means, standard deviations and ranges of the maximum incremental tests obtained before and after the resting period for both the experimental group and their controls

	STATS.	Weight (kg)	$\dot{V}_E$ Max ($l.min^{-1}$)	$\dot{V}O_2$ max ($l.min^{-1}$)	$\dot{V}O_2$ max ($ml.kg^{-1}.min^{-1}$)	R max	Heart rate max ($b.min^{-1}$)	% $\dot{V}O_2$ @ AT	HR @ AT (beats/ min^{-1})	$\dot{V}O_2$ @ AT (l)	Total time (min)	
EXPERIMENTAL	1st test	Mean	76.3	168.5	5.0	65.3	1.11	192.9	81.7	171.3	4.0	16.2
		SD	10.2	20.3	0.78	7.5	0.04	10.6	6.5	12.1	0.43	2.3
		range	58.0–89.0	145–219	3.6–6.1	55.0–80.0	1.06–1.19	168–209	73–93	150–190	3.1–4.6	12.0–19.0
	2nd test	Mean	77.5	176.3	5.2	67.1	1.16	190.3	83.3	176.1	4.4	16.9
		SD	10.0	20.8	0.87	7.6	0.05	9.2	4.2	11.0	0.76	2.2
		range	58.4–91.0	158–216	3.7–6.5	56.0–80.2	1.08–1.22	176–204	79–89	158–194	3.2–5.5	12.3–20.0
CONTROLS	1st test	Mean	72.2	170.6	5.1	70.5	1.15	191.0	80.8	173.5	4.1	15.6
		SD	9.9	11.0	0.42	6.8	0.04	11.5	8.8	10.5	0.62	3.0
		range	54.–88.5	153–190	4.5–5.8	61.0–86.0	1.09–1.20	173–218	63–92	160–196	2.90–5.20	11.3–20.5
	2nd test	Mean	72.2	171.3	4.9	69.3	1.15	190.9	81.7	173.8	4.0	15.5
		SD	10.2	18.0	0.53	8.4	0.04	8.5	10.0	9.3	0.62	2.8
		range	54.0–88.5	144–210	3.8–5.8	58.0–86.0	1.09–1.23	176–204	63–94	160–190	3.3–5.5	10.8–20.0
	F Ratio	10.5 ^b	NS	8.6 ^a	NS	10.1 ^b	NS	NS	7.5 ^a	NS	5.4 ^a	

^a = $p < 0.05$

^b = $p < 0.005$

NS = Not significant

For all abbreviations see text

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to their non-athletic controls²⁴. The POMS was also successfully used to assess regeneration techniques on different elite competitors²⁵.

Results

One way analyses of variance (ANOVA) revealed significant increases ($p < 0.05$) in the underperforming Olympic competitors' body weight (from 76.3 to 77.5 kg), R (from 1.11 to 1.16), VO_2 max (5.0 to 5.2 litres.min⁻¹), heart rate at AT (from 171 to 176 beats.min⁻¹), and the duration of the maximum

incremental tests (from 16.2 to 16.9 mins), when the data collected before and after the resting period were compared (Table 1). No changes occurred in anaerobic power/capacity measurements (Table 2). However, significant changes ($p < 0.05$) were noted in the mood states of fatigue (from 19.1 to 8.6) and vigour (from 9.4 to 18.0), as well as in the mood profile score (from 167 to 133.5) (Table 3). No significant changes were measured in any of the tested parameters in the matched control subjects despite the fact that one control demonstrated a fall in VO_2 max from 4.6 to 3.8 litres.min⁻¹ in his second test.

Table 2. Means, standard deviations and ranges for the anaerobic parameters obtained before and after the resting period for both the experimental group and their controls

		STATS.	Peak power (W)	Peak power (W.kg ⁻¹)	Mean power (W)	Mean power (W/kg ⁻¹)	Fatigue %
EXPERIMENTAL CONTROLS	1st test	Mean	702.9	8.8	581.6	7.3	31.3
		SD	134.8	1.6	83.6	1.2	6.1
		range	540–888	6.7–11.1	490–710	5.6–9.2	23–43
	2nd test	Mean	712.6	8.9	509.1	7.1	30.8
		SD	165.1	1.8	223.4	1.2	7.9
		range	520–911	6.3–11.6	509–704	5.6–9.0	23–49
	1st test	Mean	712.8	9.4	618.8	8.1	32.8
		SD	153.6	1.8	109.2	1.2	9.5
		range	520–941	6.6–12.1	486–790	5.9–9.9	19–52
	2nd test	Mean	711.3	9.4	605.1	7.9	33.3
		SD	159.8	2.0	112.2	1.2	9.0
		range	524–952	6.3–12.2	476–780	5.7–9.9	26–54
		F Ratio	NS	NS	NS	NS	NS

NS = Not significant

Table 3. Means, standard deviations and ranges obtained from the POMS questionnaire before and after the resting period for both the experiment group and their controls

STATS.			Tension	Depression	Anger	Vigour	Fatigue	Confusion	Mood profile
EXPERIMENTAL CONTROLS	1st test	Mean	15.0	17.8	11.4	9.5	19.1	12.9	167.0
		SD	6.4	8.3	4.7	4.2	4.8	5.3	23.4
		range	5–28	0–29	6–22	4–18	8–26	6–23	115–194
	2nd test	Mean	13.9	10.6	9.9	18.0	8.6	8.0	133.5
		SD	5.8	8.7	4.9	6.3	5.0	3.6	25.1
		range	5–23	0–30	4–21	6–25	1–18	4–14	101–187
	1st test	Mean	10.1	8.4	7.8	16.5	8.2	8.0	125.8
		SD	4.8	6.2	3.7	6.9	4.9	4.8	21.1
		range	3–18	1–21	1–12	2–25	0–14	2–18	90–164
	2nd test	Mean	9.8	8.0	10.4	17.2	7.3	8.2	126.5
		SD	3.8	7.5	7.6	4.3	4.6	3.7	25.5
		range	4–19	0–28	0–24	9–24	0–19	1–16	85–188
F Ratio		NS	NS	NS	8.0 ^a	14.4 ^b	NS	4.6 ^c	

^a = $p < 0.005$

^b = $p < 0.001$

^c = $p < 0.05$

NS = Not significant

Discussion

The main finding of the present study is that rest may contribute to improvements in both physiological and psychological performance related parameters in both physiological and psychological performance related parameters in underperforming Olympic competitors. Previously published data indicate that prolonged physical rest has detrimental effects on physical performance in healthy individuals^{18,26}, but there are no comparable data on elite competitors. Also, it has been suggested that light exercise during the resting period may be a better approach for treating chronically fatigued competitors than complete inactivity².

The observed high levels of maximum heart rate indicate that elite competitors learn through training how to exercise to their maximum capacities, despite the fact that they may be underperforming. However, following the first set of tests, five of the subjects described an increase in fatigue lasting more than a week.

The fact that most of the underperforming competitors of the present study came from aerobic sports is noteworthy. Excluding the changes in body weight, only cardiorespiratory parameters, which are normally associated with aerobic metabolism, were affected by the resting period. This would seem to indicate that aerobic energy production mechanisms may be more vulnerable to increased training loads, compared to anaerobic mechanisms. Indeed, despite some disagreement⁴, a decreased maximal oxygen uptake has been observed in different elite competitors²⁵, and speed skaters²⁷ as a result of intense training, leading to significant decrements in performance. It is possible that the increased activity of free radicals produced as by-products of oxygen metabolism may play a part in damaging tissues which are inadequately protected by antioxidants²⁸. This may explain why most of the competitors assessed in this study participated in aerobic sports.

The individuals most prone to reach an underperformance or burnout condition are the highly motivated, the overachievers, the successful competitors, and those who set particularly high standards for themselves^{7,29}. Psychological research also suggests that the more focus individuals place on their body and on their perception of health and physical performance, the worse they may feel¹¹. Indeed, depression has been shown to be related to staleness in swimmers¹². In the present study, depression was higher before than after the resting period (Table 3), although not significantly so.

The significant reduction of the mood dimension of fatigue following the resting period, reinforces previously published work in swimmers regarding changes in mood characteristics following periods of increased training⁶. Interestingly, the present findings are in line with the main effects of heavy training, namely increased fatigue and decreased vigour²⁵. Such psychological changes may well reduce immunity to viral infections^{13,29}, with catastrophic results for the competitor's performance.

Despite the fact that physical rest produced lower negative states of tension, depression, fatigue, anger,

Table 4. Means of normals, regular and elite runners (adapted from Frazier, 1988)

VARIABLES	Test norms	Regular runners (N = 86)	Elite runners (N = 27)
Tension	13.5	9.6	10.0
Depression	14.0	7.5	8.0
Anger	9.5	7.4	8.0
Vigor	15.5	19.7	21.0
Fatigue	10.5	8.0	7.0
Confusion	11.0	5.9	7.0

and confusion, and a higher positive state of vigour for the experimental group, the values were still slightly higher than those reported for normal individuals, regular male and female runners, and their elite counterparts, as well as the present matched controls (Tables 3 and 4). This may indicate that the subjects' mood state as measured by the POMS has not yet reached its optimum level.

The present results also indicate that the increased mood state of fatigue and vigour are directly related to changes in certain physiological parameters such as R, VO_2 max and heart rate at AT. The latter parameters are regarded as the main determinants of maximum performance in aerobic events. Furthermore, a high R value is normally associated with an increased blood lactate concentration, with lactate being regarded as a limiting factor in exercise to exhaustion³⁰. It is not surprising, therefore, that the overtrained competitors' performance decreases, nor is it surprising that competitors are unable to train at customary levels of intensity.

In conclusion, the present data show that resting for 3–5 weeks assists underperforming elite competitors to improve their aerobic performance and to improve certain mood states. However, whether these improvements enable competitors to return to their full effort training activities remains to be seen. Nevertheless, optimum monitoring may assist coaches to modify training programmes before the state of overtraining re-appears.

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