Laurea specialistica in Scienze e tecniche dello sport

Biomeccanica del movimento e dello sport ARDIGO' 20 (2010/2011)

La locomozione e le 'interferenze' ambientali

Giovedì 14 Aprile h. 13:30÷15 Biomeccanica del movimento e dello sport ARDIGO' 24

Luca P. Ardigò

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CASE REPORT

Physiological Adaptation of a Mature Adult Walking the Alps

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Research on endurance locomotion has mainly focused on elite athletes rather than common middle-aged subjects. Our report describes the physiological and hematological adaptation of a healthy, active 62-year-old man who trekked alone along a 1300 km/3 month course of Alpine paths (Via Alpina). The following procedures were conducted: pre- and post-trekking and fortnightly field anthropometry (total and lean body mass), functional tests (isometric maximal voluntary force, spontaneous walking speed, relative metabolic cost, and peak oxygen consumption) and clinical chemistry/hematological measurements with laboratory instruments; daily self-administered effort measurements using portable devices along the route (walked distance, ascent, descent, time, metabolic consumption, and cost). Despite the tough trekking route, the subject completed the trek without any worsening of his performance, or any significant health or functional problems. In addition, his peak oxygen consumption increased by 13.2%. His successful adaptation may be attributed to his constant, repeated middle-intensity and extensive exercise and lengthy exposure to high altitude. The clinical chemistry/hematological measurements documented his physiological adaptation. In conclusion, we show how an active, middle-aged man can successfully face endurance trekking, not only without any harm to his health or functions but also with an increase in his capacity to support specific effort.

Key Words: physical endurance, walking, middle-aged, physiological adaptation

Introduction

Both endurance walking and running are used in basic life functions, such as retrieving food, colonizing new habitats, mating, and escaping hazards.[1–3] Walking and running have been included in modern exercise recommendations by several authoritative guidelines.[4] It is widely acknowledged that the study of extremes helps us understand general biological phenomena. Extreme conditions, including endurance performances, refer to long-distance racing,[1,5–10] challenging environmental conditions (eg, desert, mountain, and polar expeditions[1,5,8,9,11]), and strenuous physical activity (eg, man-hauling[1,8,11]). Investigations into endurance methods in extreme conditions have included walking,[1,8] running,[1,5,7–9] swimming,[9] cycling,[1,6,7,12] kayaking,[9] and multi-discipline races.[9] The research into extreme endurance locomotion has involved both able-bodied and disabled subjects.[6]

Traditionally, these studies tend to enlist top athletes. However, studying the physiological characteristics of amateurs may reveal traits which may benefit nonelite athletes. The aim of this investigation is to describe the physiological changes that were recorded in a 62-year-old man who trekked a very long distance (> 1300 km) following the mountain path route that is known as the Via Alpina.[14]

Methods

THE SUBJECT

The subject is an Italian male, aged 62, with a body mass of 75 kg, height 178.5 cm, and BMI of 23.5 (pre-trekking measurements). He is retired and physically active, mainly performing downhill skiing, open water (sea) swimming, and trekking. Testing procedures were ex-

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Figure 1

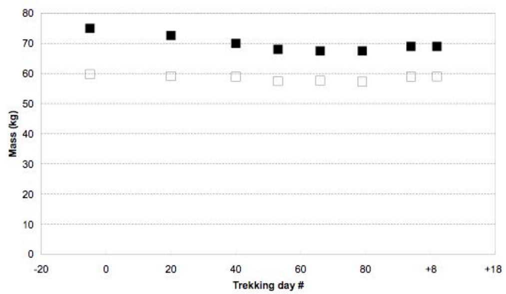


Figure 2

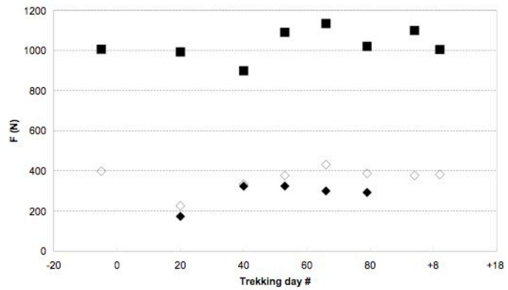


Figure 3a

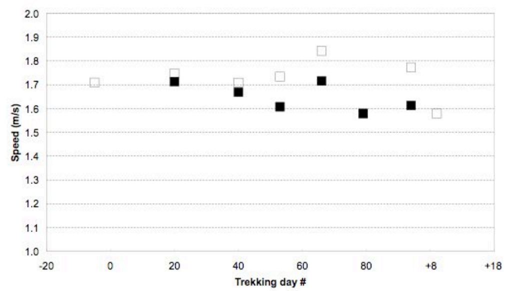
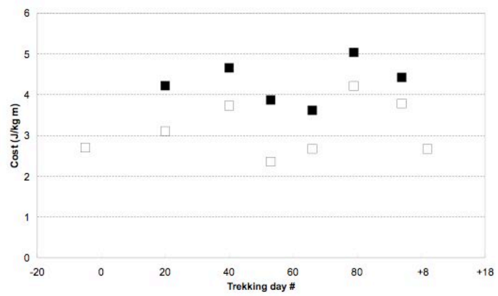

2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
Speed (m/s)
-20
0
20
40
60
80
+8
+18
Trekking day #

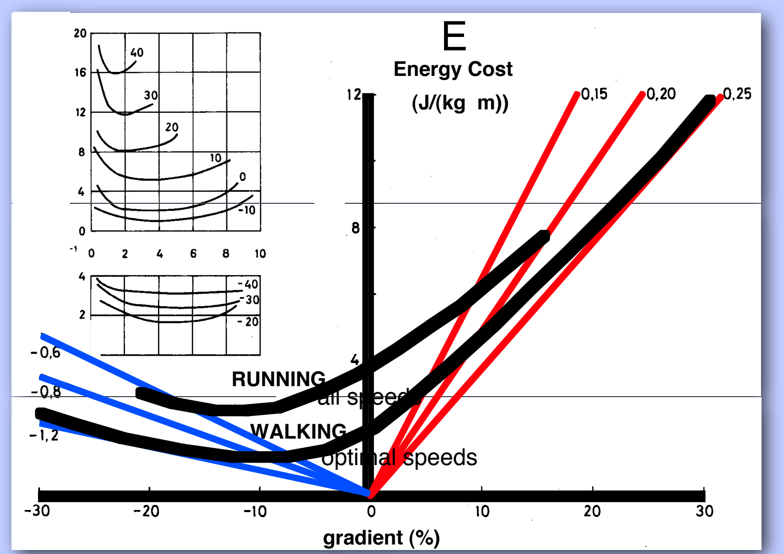
Figure 3b



Pendenza

marcia e corsa

C vs. pendenza



from: Margaria, R., 1976. Biomechanics and energetics of muscular exercise. Oxford: Clarendon Press.

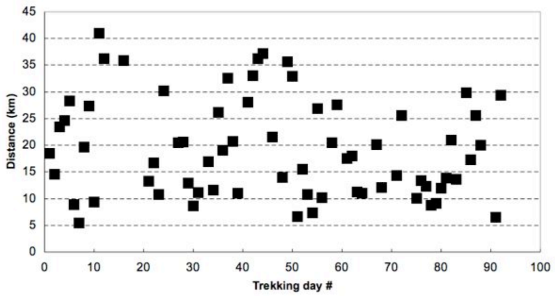
Table 1. Complete results of laboratory and field physiological testing (bold values are particularly significant, see text for explanation)

	Trekking day #							
	−5	*20*	*40*	*53*	*66*	*79*	*+2*	*+10*
Total body mass (kg)	**75.0**	72.6	70.0	**68.0**	67.5	67.5	69.0	69.0
Lean body mass (kg)	**59.8**	59.1	58.9	**57.5**	57.7	57.3	59.0	59.0
BMI	**23.5**	22.8	22.0	**21.3**	21.2	21.2	21.7	21.8
Fat (%)	**20.3**	18.6	15.8	**15.5**	14.6	15.1	14.6	14.5
Knee extensors MVF (N)	1006	992	898	1090	1134	1020	1099	1004
Left elbow flexors MVF (N)	399	226	333	377	431	387	377	382
Right elbow flexors MVF (N) [a]		173	324	324	300	292		
SWS w/o rucksack ($m\ s^{-1}$)	1.71	1.75	1.71	1.73	1.84	1.58	1.77	1.58
Metabolic cost at SWS w/o rucksack ($J\ kg^{-1}\ m^{-1}$)	2.70	3.10	3.73	2.36	2.67	4.21	3.78	2.67
SWS w/rucksack ($m\ s^{-1}$)		1.71	1.67	1.61	1.72	1.58	1.61	
Metabolic cost at SWS w/rucksack ($J\ kg^{-1}\ m^{-1}$)		4.22	4.66	3.87	3.62	5.04	4.42	
Peak oxygen consumption/kg ($ml\ O_2\ kg^{-1}\ min^{-1}$)	**40.97**							**50.43**
Peak oxygen consumption ($l\ O_2\ min^{-1}$)	**3.07**							**3.48**

[a]missing values due to shoulder pain from a past accident
MVF maximal voluntary force; SWS spontaneous walking speed.

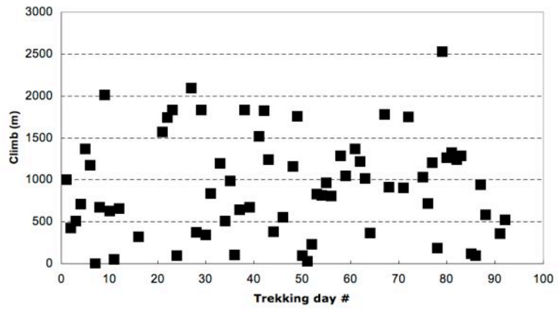
Besançon
Franche-Comté
Bern
Austria
Tirol (Tyrol)
Kärnten (Carinthia)
Trentino-Alto Adige
Ljubljana
Slovenia
Lombardia
Veneto
Milano (Milan)
Torino
Piemonte
Genova
Emilia-Romagna
Provence-Alpes-Côte d'Azur
Nice
Monaco
Marseille
Ligurian Sea
Isola Palmaria
San Marino
(Florence) Firenze
Krk
Image © 2010 IGN-France
US Dept of State Geographer
© 2010 Europa Technologies
© 2010 Tele Atlas
©2009 Google
45°50'19.16" N 10°13'35.53" E elev 1084 m
Eye alt 676.89 km

Figure 5



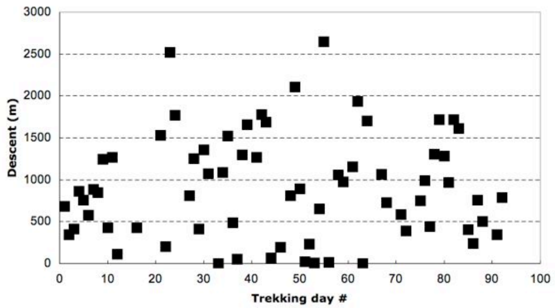
Distance (km)
Trekking day #
0
5
10
15
20
25
30
35
40
45
0
10
20
30
40
50
60
70
80
90
100

Figure 6a



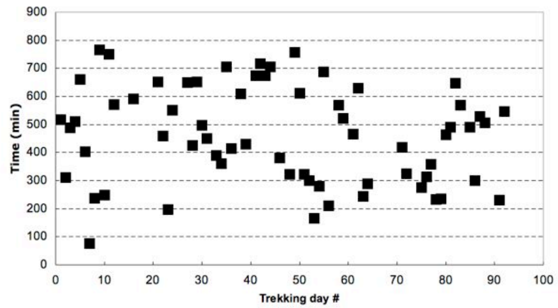
3000
2500
2000
1500
1000
500
0
Climb (m)
0
10
20
30
40
50
60
70
80
90
100
Trekking day #

Figure 6b



3000
2500
2000
1500
1000
500
0
Descent (m)
0
10
20
30
40
50
60
70
80
90
100
Trekking day #

Figure 7a



Time (min)
900
800
700
600
500
400
300
200
100
0
0
10
20
30
40
50
60
70
80
90
100
Trekking day #

Figure 7b

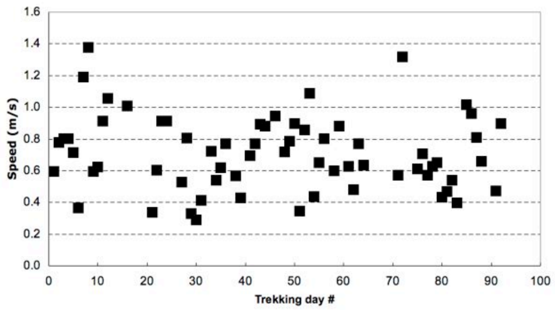
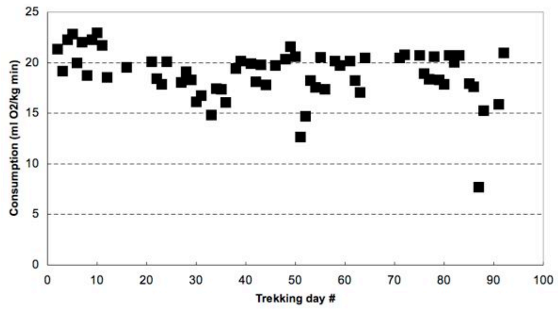
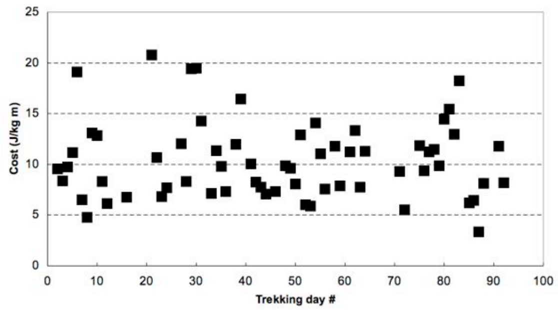

1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Speed (m/s)
0
10
20
30
40
50
60
70
80
90
100
Trekking day #

Figure 8a



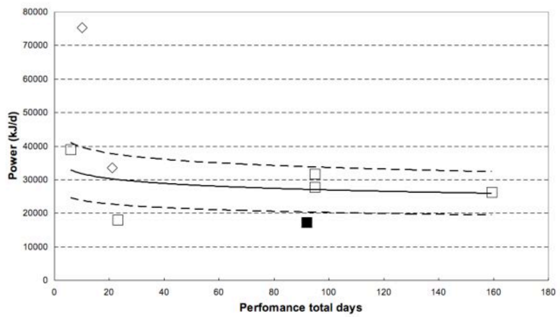
Consumption (ml O2/kg min)
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100
Trekking day #

Figure 8b



25
20
15
10
5
0
Cost (J/kg m)
0
10
20
30
40
50
60
70
80
90
100
Trekking day #

Figure 9



80000
70000
60000
50000
40000
30000
20000
10000
0
Power (kJ/d)
0
20
40
60
80
100
120
140
160
180
Perfomance total days

Table 2. Complete results of clinical chemistry and hematological testing

Reference	Range	*Trekking day #* −5	20	40	53	66	79	+2	+10
White blood cell count (10^6 L^{-1})	3.5–9.0	5.67	5.15				6.49	6.62	6.26
Red Blood Cell count (10^{12} L^{-1})	4.2–5.7	4.37	4.71				4.15	4.72	4.33
Hemoglobin (g L^{-1})	13.0–16.2	13.70	14.6				13.4	15.1	13.8
Hematocrit (%)	40–50	41.60	45.9				40.1	47.3	42.9
Platelet count (10^9 L^{-1})	150–400	179	147				203	215	199
Alkaline Phosphatase (U L^{-1})	53–128	53	43	46	47	54	49	72	49
Amylase (U L^{-1})	53–123	66	80	63	75	94	110	125	98
Cholesterol, total (mg dL^{-1})	120–200	228	208	201	180	213	214	217	191
Creatine Kinase (U L^{-1})	24–174	70	58	109	75	67	124	80	52
Aspartate aminotransferase (U L^{-1})	8–40	19	22	22	22	20	26	31	18
Lipase (U L^{-1})	10–150	39	45	42	68	108	219	414	249
Triglycerides (mg dL^{-1})	70–150	173	128	48	67	90	87	198	104
Alanine aminotransferase (U L^{-1})	5–21	19	22	15	18	16	23	23	16
High–density Lipoprotein Cholesterol (mg dL^{-1})		52	62	90	73	76	68	63	53
C–reactive Protein (mg L^{-1})	< 5	2	2.3	5.1	9.3	3.4	3.3	15.6	4.2
Myoglobin (ng mL^{-1})	17–106	21	21.11	27.61	32.18	26.41	31.65	21	30.39
Pro–brain Natriuretic Peptide (pg mL^{-1})	< 140	65.17	44.78	116.2	76.92	50.75	91.58	36.9	77.53

Disponibili tirocini, tesi triennale e specialistica (1: 5)

- Recupero corsa in avanti vs. corsa all'indietro;

- bioenergetica della corsa prolungata in pista e su treadmill;

- bioenergetica & biomeccanica della corsa prolungata (MF);

- bioenergetica & biomeccanica dell'in-line skating (MpF);

- bioenergetica & biomeccanica dell'handbiking (PhD p);

Disponibili tirocini, tesi triennale e magistrale (2: 6)

- bioenergetica & biomeccanica dell'handbiking dopo RMET (PhD p);
- bioenergetica & biomeccanica dell'handbiking dopo HIT (PhD p);
- bioenergetica & biomeccanica dopo long bed rest (MF);
- bioenergetica & biomeccanica del nordic running;
- bioenergetica & biomeccanica di vari trekking (MF);
- costo metabolico marcia, corsa, ciclismo e sci di fondo stessi soggetti;

Disponibili tirocini, tesi triennale e magistrale (3: 5)

- costo EMG della marcia (MF);

- frequenza di skipping e costo metabolico della corsa (MpF);

- review dei sistemi di misura portatili dell'attività fisica e del dispendio metabolico (C);

- salto in lungo da fermo con masse aggiunte ed allenamento;

- bioenergetica e biomeccanica della regata velica.