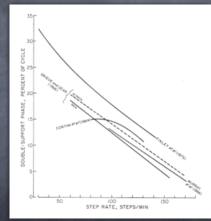
Biomeccanica II

Lez. BM8

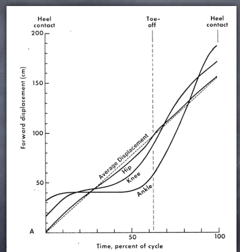
Lunedì 27 Aprile 2009 10:30÷12

Luca P. Ardigò

The double support phase decreases as the walking rate increases



Progression speed of different body segments in walking



ORIGINAL ARTICLE

Metabolic and Mechanical Energy Costs of Reducing Vertical Center of Mass Movement During Gait

Keith E. Gordon, PhD, Daniel P. Ferris, PhD, Arthur D. Kuo, PhD

ABSTRACT. Gordon KE, Ferris DP, Kuo AD. Metabolic and mechanical energy costs of reducing vertical center of mass movement during gait. Arch Phys Med Rehabil 2009;90: 136-44.

the COM each step. One might then conclude that the metabolic energy requirements of gait could be reduced by actively decreasing or minimizing vertical COM movement. However, recent studies[7,8] show that humans do not minimize vertical

Objectives: To test the hypothesis that reducing vertical center of mass (COM) displacement will lower the metabolic cost of human walking. To examine changes in joint work associated with increasing and decreasing vertical COM movement during gait.

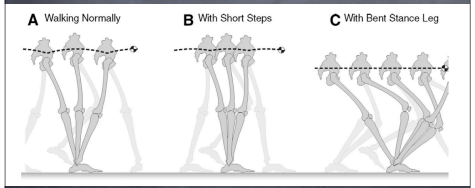
Design: Randomized repeated measures.

Setting: Human Neuromechanics Laboratory, University of Michigan.

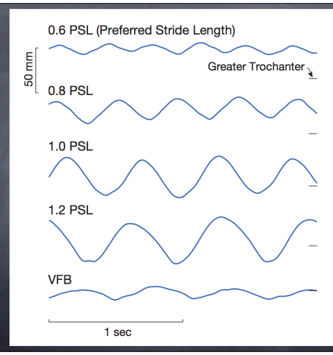
Participants: Able-bodied subjects (N=10).

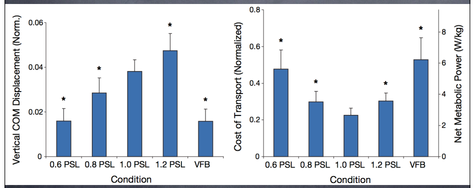
Interventions: Subjects walked at 1.2m/s on a treadmill and overground. Subjects manipulated vertical COM displacement either by adjusting stride length or by using visual feedback to reduce COM movement.

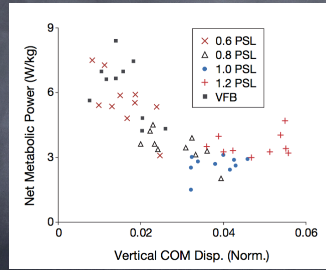
Main Outcome Measures: We measured kinematic and kinetic data to calculate vertical and lateral COM displacements, joint torques, and work. In addition, we collected oxygen consumption to calculated metabolic power.

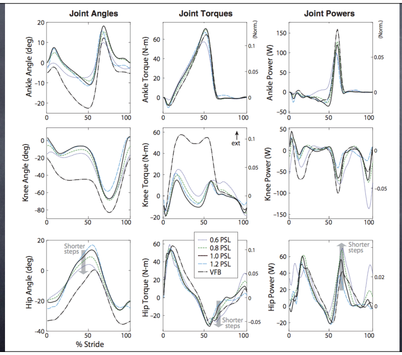


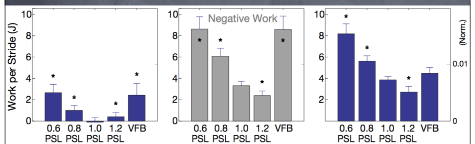
Condition	Energy Expenditure (Cost of Transport)	Vertical COM Displacement (% L)	Lateral COM Displacement (% L)	Ankle Work Per Stride (J)	Knee Work Per Stride (J)	Hip Work Per Stride (J)
0.6 PSL	0.47±0.10*	1.60±0.56*	1.08±0.27*	2.66±2.44*	–8.63±2.56*	8.18±2.45*
0.8 PSL	0.29±0.05*	2.85±0.67*	1.83±0.47*	1.00±1.45*	–6.07±2.18*	5.62±1.38*
1.0 PSL	0.22±0.03	3.82±0.52	3.31±0.44	–0.10±1.00*	–3.32±1.28*	3.87±1.26*
1.2 PSL	0.30±0.04*	4.75±0.76*	4.37±0.40*	0.41±0.77*	–2.39±1.04*	2.72±1.35*
VFB	0.52±0.11*	1.58±0.55*	3.74±0.40	2.43±1.58*	–8.57±2.88*	4.48±2.34
ANOVA	7.4E–13	3.6E–12	2.5E–7	0.022	9.3E–04	0.0015




Vertical COM Displacement (Norm.)
0.6 PSL
0.8 PSL
1.0 PSL
1.2 PSL
VFB
Condition
Cost of Transport (Normalized)
Net Metabolic Power (W/kg)


Net Metabolic Power (W/kg)
Vertical COM Disp. (Norm.)
0.6 PSL
0.8 PSL
1.0 PSL
1.2 PSL
VFB


Joint Angles
Joint Torques
Joint Powers
Ankle Angle (deg)
Ankle Torque (N-m)
Ankle Power (W)
Knee Angle (deg)
Knee Torque (N-m)
Knee Power (W)
Hip Angle (deg)
Hip Torque (N-m)
Hip Power (W)
Shorter steps
% Stride
0.6 PSL
0.8 PSL
1.0 PSL
1.2 PSL
VFB
(Norm.)
ext


Work per Stride (J)
Negative Work
0.6 PSL
0.8 PSL
1.0 PSL
1.2 PSL
VFB
(Norm.)

Results: Increasing and decreasing vertical COM displacement beyond subjects' preferred range resulted in increases in the metabolic cost of walking. When vertical COM displacement was reduced, corresponding increases in positive ankle and hip work and negative knee work were observed.

Conclusions: Humans are capable of walking in a manner that will reduce COM displacement from normal. Decreasing vertical COM movement results in increases in metabolic energy costs because of greater mechanical work performed at the hip, knee, and ankle joints. Thus, reducing vertical COM movement is not a successful strategy for improving either metabolic or mechanical energy economy during normal walking by able-bodied subjects.

ORIGINAL ARTICLE

The Role of Free-Living Daily Walking in Human Weight Gain and Obesity

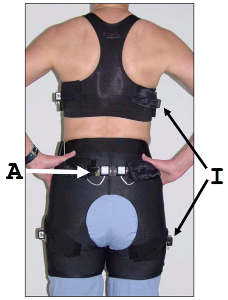
James A. Levine, Shelly K. McCrady, Lorraine M. Lanningham-Foster, Paul H. Kane,
Randal C. Foster, and Chinmay U. Manohar

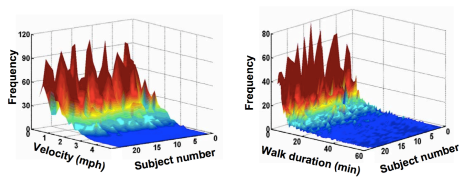
Diabetes 57:548–554, 2008

OBJECTIVE—Diminished daily physical activity explains, in part, why obesity and diabetes have become worldwide epidemics. In particular, chair use has replaced ambulation, so that obese individuals tend to sit for ~2.5 h/day more than lean counterparts. Here, we address the hypotheses that free-living daily walking distance is decreased in obesity compared with lean subjects and that experimental weight gain precipitates decreased daily walking.

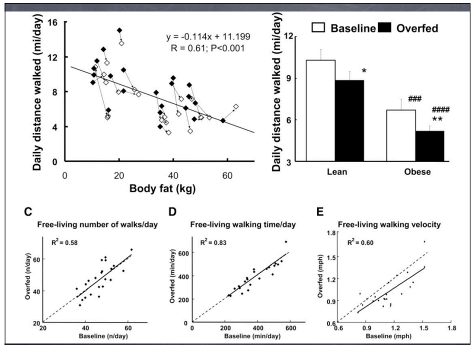
RESEARCH DESIGN AND METHODS—During weight-maintenance feeding, we measured free-living walking using a validated system that captures locomotion and body movement for 10 days in 22 healthy lean and obese sedentary individuals. These measurements were then repeated after the lean and obese subjects were overfed by 1,000 kcal/day for 8 weeks.

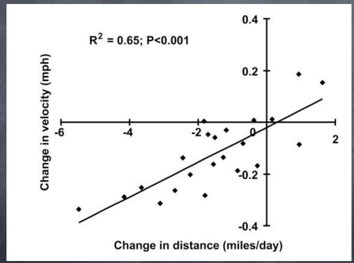
Subject	Sex	Age (years)	Weight maintenance energy intake (kcal/day)	BMI (kg/m^2)	Change in BMI (kg/m^2)
Lean (BMI <25 kg/m^2)					
1	W	44	1,815	19	1.55
2	W	39	2,360	20	0.54
3	M	33	2,710	21	2.27
4	M	27	2,037	22	0.24
5	W	41	2,142	22	0.24
6	M	34	2,706	23	0.87
7	W	29	2,354	23	2.13
8	M	53	2,589	24	0.77
9	W	55	1,904	25	2.17
10	M	29	2,628	25	1.22
Obese (BMI >29 kg/m^2)					
11	M	40	2,885	29	1.73
12	M	29	3,068	31	1.13
13	W	47	2,428	32	1.11
14	W	42	2,402	32	1.01
15	W	41	2,423	33	0.48
16	M	36	3,470	33	2.25
17	W	38	2,551	34	1.01
18	W	41	3,220	35	1.41
19	W	41	2,362	35	1.00
20	M	41	2,303	35	2.09
21	M	27	4,266	37	1.35
22	W	31	2,623	38	1.02





	Walking bouts (n/day)	Time engaged in walking (minutes/day)	Average distance of a walking bout (miles)	Free-living walking velocity (mph)
Baseline				
Lean	46 + 8	448 + 111	0.22 + 0.04	1.19 + 0.21
Obese	47 + 5	339 + 74#	0.14 + 0.04##	1.10 + 0.20
TOTAL	47 + 6	389 + 106	0.18 + 0.06	1.14 + 0.20
Overfed				
Lean	48 + 11	459 + 119	0.19 + 0.06*	1.09 + 0.28
Obese	47 + 9	334 + 79#	0.11 + 0.03### ****	0.96 + 0.15**
TOTAL	47 + 10	391 + 116	0.15 + 0.06*****	1.02 + 0.20*****
Change with overfeeding				
Lean	1.6 + 5	11 + 43	-0.03 + 0.04	-0.10 + 0.14
Obese	-0.3 + 7	-5 + 51	-0.03 + 0.05	-0.14 + 0.15
TOTAL	0.6 + 6	2 + 47	-0.03 + 0.04	-0.12 + 0.14





RESULTS—We found that free-living walking comprises many (~47) short-duration (<15 min), low-velocity (~1 mph) walking bouts. Lean subjects walked 3.5 miles/day more than obese subjects (n = 10, 10.3 ± 2.5 vs. n = 12, 6.7 ± 1.8 miles/day; P = 0.0009). With overfeeding, walking distance decreased by 1.5 miles/day compared with baseline values (−1.5 ± 1.7 miles/day; P = 0.0005). The decrease in walking that accompanied overfeeding occurred to a similar degree in the lean (−1.4 ± 1.9 miles/day; P = 0.04) and obese (−1.6 ± 1.7 miles/day; P = 0.008) subjects.

CONCLUSIONS—Walking is decreased in obesity and declines with weight gain. This may represent a continuum whereby progressive increases in weight are associated with progressive decreases in walking distance. By identifying walking as pivotal in weight gain and obesity, we hope to add credence to an argument for an ambulatory future. ***Diabetes* 57:548–554, 2008**

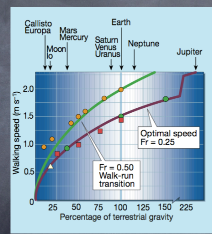
Biomechanics

Walking on other planets

Alberto E. Minetti

A nineteenth-century equation used for building model ships allows us to compare the motion of animals of different sizes and gaits. It may also give us an idea of how we would move on different planets.

NATURE | VOL 409 | 25 JANUARY 2001 | www.nature.com



Disponibili tirocini, tesi triennale e specialistica

- Bioenergetica & biomeccanica del nordic walking;

- bioenergetica & biomeccanica della locomozione acquatica;

- bioenergetica & biomeccanica dell'inline skating;

- bioenergetica & biomeccanica dell'hand-cycling;

- bioenergetica & biomeccanicadel del long bed rest;

- bioenergetica & biomeccanica del trekking delle alpi;

Disponibili tirocini, tesi triennale e specialistica (2)

- costo emg della locomozione;

- review dei sistemi misura portatili dell'attività fisica e del dispendio metabolico; e

- salto in lungo da fermo con masse aggiunte e allenamento.