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Research Article

Comparitive study of energy expenditure per unit time on track and treadmill during walking and running (1 mile)

K. Manas Chakravarthy[1], R. Karuna Devi[*2] and KPS. Adinarayana[3]

[1]*Tutor, Department of Physiology, NRI Institute of Medical Sciences, NTR Health University, Visakhapatnam-531162, Andhrapradesh, India.*
[2]*Associate Professor, Department of Physiology, NRI Institute of Medical Sciences, NTR Health University, Visakhapatnam-531162, Andhrapradesh, India.*
[3]*Associate Professor, Department of Anatomy, Andhra Medical College, Visakhapatnam-530001, Andhra Pradesh, India.*

*** Correspondence Info:**
Dr. K. Manas Chakravarthy,
D. No-1-4-410, Kummarathopu,Tirupathi-517501, India
E- mail: manaschakravarthy87@gmail.com

Abstract

A study was done to compare energy expenditure per unit time for a group of students doing exercises on Treadmill and Track while running and walking. The effect of body mass on expenditure of energy in unit time was compared while running on Track and Treadmill and while walking on Track and Treadmill. The effect of speed on energy expenditure per unit time was also studied. The study reveals energy expenditure per unit time in the same person was more on Track walking and Track running when compared with Treadmill walking and Treadmill running in the study group taken. It also revealed that increased energy expenditure was necessary with increased body mass in both Track and Treadmill running and walking. When there is increase in the speed of the exercise, there was increased energy expenditure per unit time.

Keywords: Energy expenditure, Body mass, Speed, Walking, Running

1. Introduction

The potential differences in energy expenditure during Track and Treadmill exercises is crucial in prescribing exercises for weight loss in obese people. For this purpose the study was undertaken to compare energy expenditure on Treadmill and Track, running and walking. The primary difference between free range running on Track and Treadmill running is lack of wind resistance in Treadmill running[2]; the flat unchanging surface of Treadmill deck, and the effect of moving belt on your running and walking style. These factors make the Treadmill running slightly easier than the free range running.

When running on a Treadmill you are running in a fixed place, you are not moving through the air, whereas when you run outside the air creates resistance. Studies are estimated that outside air resistance creates an increase in your workload up to 2% to 10%. Lack of wind means you spend less energy, but again this depends upon the type of surface you are walking. Less energy is expended on a grass Track (or) paved surface, the energy cost almost doubles while walking on sand or soft snow.

2. Materials and methods

The institution ethical committee approval was obtained.

a) Study population

The present study was conducted in the Department of Physiology, SVIMS University, Tirupathi. The study group consisted of 40 healthy male subjects in the age group of 18- 25 years studying in SVIMS University were taken.

b) Inclusive criteria

1. The subject should be recreationally active.

2. The subject should be free of respiratory disorders and should be disease free taking no medications.

3. The subject should be able to walk and run on Treadmill and Track.

4. The subject should be in normal range of BMI[3].

c) Instruments

- Motorized HK – 3000 Treadmill is used to study energy expenditure while walking and running.
- 1600 m Track - measured by using open wheel PVC tape.
- Sphygmomanometer
- Stethoscope

The students were given orientation of the study.

Each subject had a total of 5 visits.

- In the first visit informed cons cent was taken.
- Collection of initial demographics such as weight, height, age, heart rate, blood pressure was done.
- The procedure of test was demonstrated to the subjects, and asked them to wear light-weight clothes and shoes, while walking and running on Treadmill and Track.
- Energy expenditure was calculated using heart rate, age, weight and time.
- Energy expenditure per unit time was also calculated.
- Energy expenditure per unit time was compared between individuals of different weight groups.
- On Track Energy expenditure per unit time was compared with different speeds.
- All visits had a minimum of 24hrs gap between each visit to avoid carry over effects on energy expenditure, which have influence on fatigue.
- They were divided into 2 groups. Each group is asked to attend on alternate days to perform walking and running on Treadmill and Track.
- Energy expenditure per unit time was calculated in persons of different body weight for same physical activity.
- The energy cost of locomotion depends largely on body size.

3. Result

The present study demonstrates, more energy is utilized per unit time for doing the same work by a person on Track than Treadmill[1]. It was also observed persons with more body mass require more energy to do the same work when compared with their counter parts of less body mass[4]. Similarly a direct relation was seen between speed and power output. As optimum movement speed increases, power output also increases[5].

Table - 1 Comparison of energy expenditure per unit time during track walking and running

S. No	Age (in Years)	Weight (in Kgs)	BMI	Distance (in meters)	Track walking			Distance (in meters)	Track Running		
					Time (in min)	D/T = speed (m/min)	Power (Kg. m/min)		Time (in min)	D/T = speed (m/min)	Power (Kg. m/min)
1	18	43	18.3	1600	14.05	113.88	4896.8	1600	6.4	250.00	10750
2	23	47	19.1	1600	14.17	112.91	5307	1600	5.19	308.29	14489
3	19	48	18.52	1600	14.22	112.52	5400.8	1600	7.13	224.40	10771.4
4	20	48	18.75	1600	13.38	119.58	5739.9	1600	6.59	242.79	11654.0
5	23	49	18.28	1600	15.32	104.44	5117.5	1600	4.56	350.88	17193.0
6	23	49	18.28	1600	14.55	109.97	5388.3	1600	5.58	286.74	14050.2
7	18	50	19.3	1600	12.36	129.45	6472.5	1600	6.12	261.44	13071.9
8	20	51	21.25	1600	15.34	104.30	5319.4	1600	6.1	262.30	13377.1
9	19	52	19.85	1600	14.29	111.97	5822.3	1600	5.13	311.89	16218.3
10	19	53	20	1600	13.44	119.05	6309.5	1600	7.3	219.18	11616.4
11	20	53	19.27	1600	15.32	104.44	5535.2	1600	7.28	219.78	11648.4
12	18	53	20.22	1600	16.05	99.69	5283.5	1600	6.03	265.34	14063.0
13	24	55	19.03	1600	11.58	138.17	7599.3	1600	8.22	194.65	10705.6
14	19	55	21.23	1600	15.19	105.33	5793.4	1600	5.56	287.77	15827.3
15	21	55	22.9	1600	14.38	111.27	6119.6	1600	5.12	312.50	17187.5
16	18	56	20.14	1600	14.12	113.31	6345.6	1600	5.19	308.29	17264.0
17	18	57	20.5	1600	14.18	112.83	6431.6	1600	4.36	366.97	20917.4
18	19	57	18.03	1600	15.2	105.26	6000	1600	7.58	211.08	12031.7
19	21	58	18.7	1600	14.52	110.19	6391.2	1600	6.27	255.18	14800.6
20	19	58	19.2	1600	14.39	111.19	6448.9	1600	6.11	261.87	15188.2
21	20	58	19.86	1600	16.16	99.01	5742.6	1600	5.27	303.61	17609.1
22	18	58	20.06	1600	15.18	105.40	6113.3	1600	6.07	263.59	15288.3
23	23	59	20.92	1600	14.45	110.73	6532.9	1600	5.14	311.28	18365.8
24	21	59	18.03	1600	17.09	93.62	5523.7	1600	7.25	220.69	13020.7
25	21	60	22.3	1600	14.44	110.80	6648.1	1600	6.53	245.02	14701.4
26	24	61	23.82	1600	15.04	106.38	6489.4	1600	5.51	290.38	17713.2
27	22	63	21.7	1600	14.59	109.66	6908.8	1600	6.41	249.61	15725.4
28	19	64	22.69	1600	16.09	99.44	6364.2	1600	5.37	297.95	19068.9
29	19	64	23.27	1600	16.15	99.07	6364.6	1600	6.05	264.46	16925.6
30	19	66	23.74	1600	16.15	99.07	6538.8	1600	8.44	189.57	12511.8
31	21	66	21.08	1600	15.13	105.75	6979.5	1600	6.59	242.79	16024.4
32	21	68	23.2	1600	14.49	110.42	7508.6	1600	7.19	222.53	15132.1
33	22	70	25.4	1600	9.09	176.02	12321	1600	7.2	222.22	15555.6
34	23	71	24.9	1600	14.26	112.20	7966.3	1600	6.16	259.74	18441.6
35	19	72	22	1600	13.03	122.79	8841.1	1600	5.3	301.89	21735.9
36	23	72	23.5	1600	14.5	110.34	7944.8	1600	6	266.67	19200.0
37	18	74	24.1	1600	14.14	113.15	8373.4	1600	5.23	305.93	22638.6
38	24	77	24	1600	15.05	106.31	8186.1	1600	7.08	225.99	17401.1
39	21	80	25	1600	16.27	98.34	7867.2	1600	7.31	218.88	17501.3
40	23	90	24.9	1600	15.03	106.45	9580.8	1600	8.31	192.54	17328.8

Table - 2 Comparison of energy expenditure per unit time during treadmill walking and running

S. No	Age (in Years)	Weight (in Kgs)	BMI	Distance (in meters)	Treadmill Walking		Treadmill Running	
					Time (in min)	Power (Kg. m/min)	Time (in min)	Power (Kg. m/min)
1	18	43	18.3	1600	26.44	2602.11	12.34	5575.36
2	23	47	19.1	1600	26.44	2844.17	12.34	6094
3	19	48	18.52	1600	26.44	2904.68	12.34	6223.66
4	20	48	18.75	1600	26.44	2904.68	12.34	6223.66
5	23	49	18.28	1600	26.44	2965.2	12.34	6353.32
6	23	49	18.28	1600	26.44	2965.2	12.34	6353.32
7	18	50	19.3	1600	26.44	3025.71	12.34	6482.98
8	20	51	21.25	1600	26.44	3086.23	12.34	6612.64
9	19	52	19.85	1600	26.44	3146.74	12.34	6742.3
10	19	53	20	1600	26.44	3207.26	12.34	6871.96
11	20	53	19.27	1600	26.44	3207.26	12.34	6871.96
12	18	53	20.22	1600	26.44	3207.26	12.34	6871.96
13	24	55	19.03	1600	26.44	3328.29	12.34	7131.28
14	19	55	21.23	1600	26.44	3328.29	12.34	7131.28
15	21	55	22.9	1600	26.44	3328.29	12.34	7131.28
16	18	56	20.14	1600	26.44	3388.29	12.34	7260.94
17	18	57	20.5	1600	26.44	3449.31	12.34	7390.59
18	19	57	18.03	1600	26.44	3449.31	12.34	7390.59
19	21	58	18.7	1600	26.44	3509.83	12.34	7220.25
20	19	58	19.2	1600	26.44	3509.83	12.34	7220.25
21	20	58	19.86	1600	26.44	3509.83	12.34	7220.25
22	18	58	20.06	1600	26.44	3509.83	12.34	7220.25
23	23	59	20.92	1600	26.44	3570.34	12.34	7649.91
24	21	59	18.03	1600	26.44	3570.34	12.34	7649.91
25	21	60	22.3	1600	26.44	3630.86	12.34	7779.57
26	24	61	23.82	1600	26.44	3691.37	12.34	7909.23
27	22	63	21.7	1600	26.44	3812.4	12.34	8168.55
28	19	64	22.69	1600	26.44	3872.91	12.34	8298.21
29	19	64	23.27	1600	26.44	3872.91	12.34	8298.21
30	19	66	23.74	1600	26.44	3993.94	12.34	8557.53
31	21	66	21.08	1600	26.44	3993.94	12.34	8557.53
32	21	68	23.2	1600	26.44	4114.97	12.34	8816.85
33	22	70	25.4	1600	26.44	4236	12.34	9076.17
34	23	71	24.9	1600	26.44	4296.52	12.34	9205.83
35	19	72	22	1600	26.44	4357.03	12.34	9335.49
36	23	72	23.5	1600	26.44	4357.03	12.34	9335.49
37	18	74	24.1	1600	26.44	4478.06	12.34	9594.81
38	24	77	24	1600	26.44	4659.6	12.34	9983.79
39	21	80	25	1600	26.44	4841.14	12.34	10372.77
40	23	90	24.9	1600	26.44	5446.29	12.34	11669.36

Fig – 1: Comparison of energy expenditure per unit time between track walking and treadmill walking

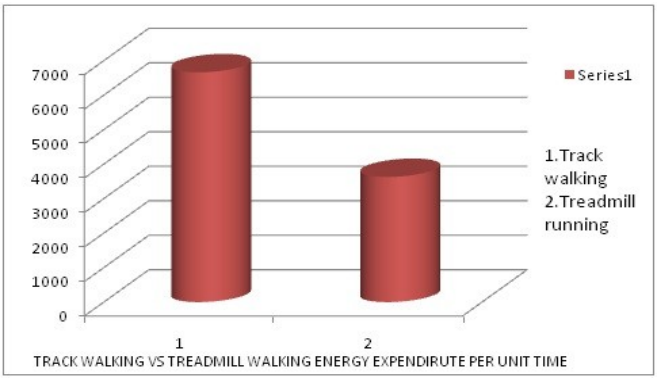
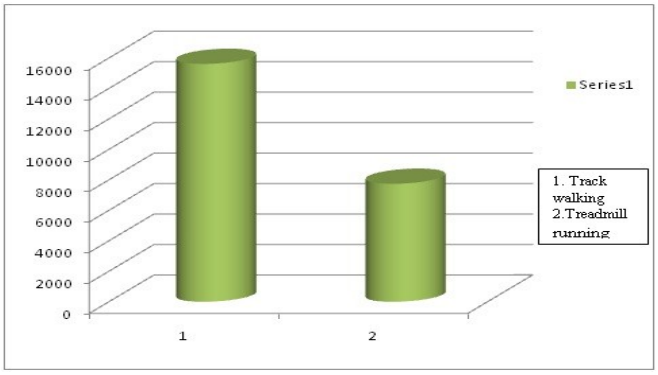
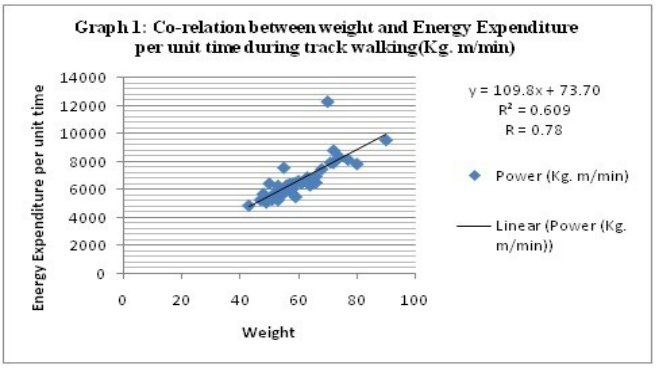
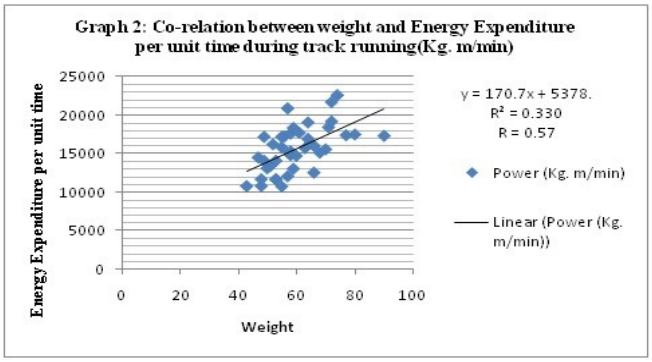
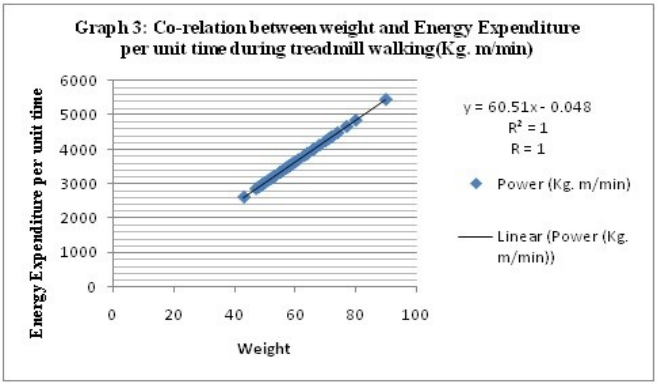


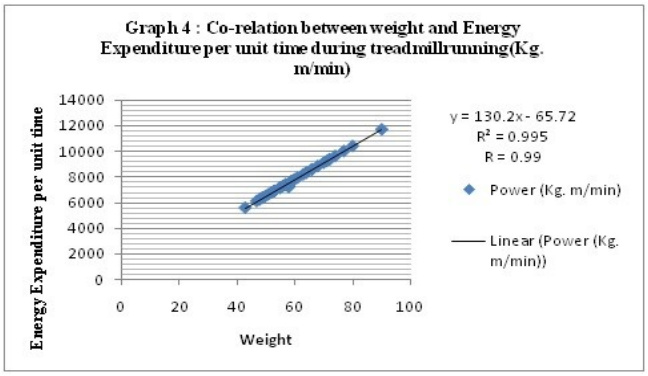
Fig – 2: Comparison of energy expenditure per unit time between track running and treadmill running











4. Discussion

More energy was seen to be expended during running than walking. When treadmill walking was compared with walking on physical path, the later results seems to be higher than the former. Similarly more energy was expended while running on track when compared with treadmill running.

While running or walking on track, more energy is expended than on Treadmill, this may be because in outdoor running your leg muscles mostly work and propel you forward, whereas in Treadmill the belt is moving under you, your leg muscles in treadmill mostly work at repositioning your legs to keep you stable[6]. This is clearly seen in figure 1 & 2 and Tables 1 & 2.

In Treadmill running the rearward moving belt decreases the need to use your body power, so it requires less work than outdoor running. In this case the subject is not changing his horizontal position and is passively moving, and is forced to catch up with the running belt underneath his foot[2].

Using a motorized Treadmill with no incline, it was seen that one burns fewer calories per mile than you do outside, since the moving Treadmill does some work.

When you run outside, you are moving over a changing terrain, the slant and incline of the ground is always changing. The surface you are running also changes, where as the surface of Treadmill is even. The road has a far higher impact level than Treadmill, in the natural terrain; each step you take produces a slightly different set of stress on your feet.

In Treadmill the problems repeat with each step. Walking outside has the biggest advantage in challenging your balance and stability with all the small obstacles you encounter.

The preceding observations about terrain footwear and economy of locomotion indicate, that at the extreme one could dramatically elevate energy cost by walking in soft sand at rapid speed, wearing heavy work boots and ankle weights.

Hand held weights also increases the energy cost of walking, particularly when arm movements accenture a pumping action.

It was also seen, calories burned is influenced by body weight, intensity of exercise, condition level, metabolism both on Track and Treadmill exercise. Energy expenditure per unit time when compared among persons of different body mass, the energy cost of same physical activity will be different for person of different body weight. The energy cost increases proportionately with the runners' body mass. This observation certainly supports the role of weight bearing exercise is a caloric stress for over-weight individuals use to increase Energy Expenditure for weight lose[7]. It was clearly seen in Graph 1, 2, 3, 4 and Tables 1 & 2.

According to Hall *et al*, Energy expenditure of walking and running, comparison with prediction equations; running required more energy both on Track and Treadmill when compared with walking, he also hypothesized that an Energy expenditure difference between the Track and Treadmill when walking or running does not exist when factors such as wind influence were controlled – speed was 2.82m/sec. (indoor Track). Running at higher speed might potentially cause wind resistance to influence energy expenditure[8].

Pugh *et al* shows the influence of wind resistance in running and walking and the mechanical efficiency of work against horizontal or vertical forces. One of the first scientific studies to compare Treadmill with Track running was carried out by physiologist Dr. LGCE Pugh in London in 1962.[2]

The main factors that influence the exercise efficiency are work rate speed of the movement, extrinsic factors such are clothing, improvement in equipment design, shoe design, muscle fiber composition, fitness level, temperature regulation, body composition and improved technique.

4.1 Speed

Increase in running speed offers the more desirable alternative increase in the Energy Expenditure per unit time. The results showed as speed increases, Energy Expenditure per unit time also increases. While walking and running represent qualitative terms related to speed of locomotion. This difference relates largely to aerobic energy demands required in raising and lowering the body's center of gravity and accelerating and decelerating the limbs during the run.

An optimum combination of stride length and frequency exists for running at a particular speed. The optimum combination largely depends on the person's style of running and cannot be determined from objective body measurements. Therefore increase in running speed offers the more desirable alternative to increase in energy expenditure per unit time[9]. The brisk walk sheds more energy than slow movements.

5. Conclusion

The data suggests in exercises on Track more energy is utilized when compared to Treadmill. Increasing body mass increases Energy Expenditure per unit time in both Treadmill and Track. Increasing speed of exercise increases energy expenditure.

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