COMPARISON OF GAIT ANALYSIS AND ENERGY EXPENDITURES BETWEEN TREADMILL AND OVERGROUND WALKING

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INTRODUCTION

Walking is most natural activity and the only sustained dynamic aerobic exercise that is common to everyone except for the seriously disabled or very frail. This is beneficial through engendering improved fitness and greater physiological activity and energy turnover [1].

The treadmill can be used to walking for the health. In previous studies, measurements were taken on the treadmill and during overground walking. And many measurements have been made of the energy expenditure of persons walking at varying speeds on level ground or on the treadmill [2]. The results for walking at rates up to 8km/hr and for running at velocities of 8-21km/hr are substantially the same as those of Margaria et al.(1963) [3]. At higher veloci-ties the relation for walking is linear as in running, but the slope is twice as steep [4]. Energy cost results were different between the treadmill and overground walking at same walking condition.

In this study, treadmill walking and overground walking were compared at the same condition based on kinematics and energy expenditures (EE). In addition, we compared the actual energy expenditure and calculated EE by treadmill.

METHODS

Healthy male subjects were participated in this study (n=11). The patient was asked to walk as the convenient speed. A six-camera three dimensional motion analysis system (VICON612, UK) was used to record kinematic data at 120 Hz. And treadmill (HP Cosmos Gatway Ⅱ) was used. We calculated energy cost values of walking on the treadmill compared to those on the portable cardiopulmonary exercise system using the clinically proven mixing chamber (Metamax 3X, GER). Equation (1) is showed Weir Method using the calculated EE by Metamax 3X [5]. And Equation (2) is showed Margria fomular using the calculated EE by treadmill [6].

$$\text{Kcal/min} = [(1.1\times \text{RER})+3.9]\times \text{VO2} \quad (1)$$

$$\text{KJ} = (2.67+(10.9+0.654\times \text{V in \%})\times(\text{S in m/sec}))\times \text{T in min} \times \text{W in kg}\times 0.0211\text{kJ/ml O2} \quad (2)$$

RESULTS AND DISCUSSION

The kinematics data of treadmill and overground walking were very similar. The values at each joint were significantly different ($p<0.05$), but magnitude of the difference was generally less than 3°. Walking conditions of treadmill walking was significantly greater when measured on overground (Table 1).

The EE of treadmill calculated was 6.3% greater than the EE of Metamax 3X in normal speed walking and there was no statistically significant difference. And The EE of treadmill calculated was 11.7% greater than the EE of Metamax 3X in fast speed walking. There was a statistically significant difference (Figure 1).

Table 1: Energy Expenditure in Treadmill vs Overground

Walking Conditions	Treadmill		Overground	
speed	normal	fast	normal	fast
*Heart Rate[1/min]	111.6±2	133.6±2.6	95.6±2	118.4±1.6
*Rel. O_2 Uptake [ml/min/kg]	19±1	28.8±1	17±0.6	19.4±0.6
*EE [kcal/min]	128.9±4.7	197.6±5.4	107.6±4.9	146.1±5.3

*represents significant difference ($P<0.05$)

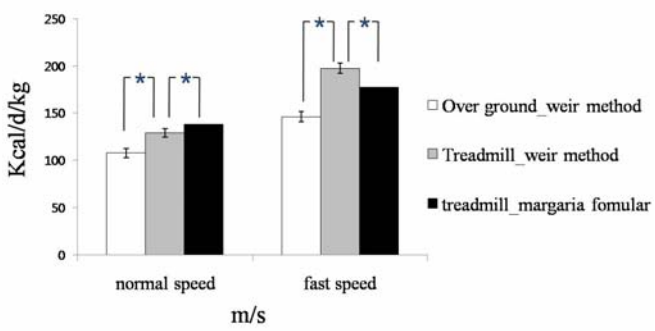

Figure 1: Energy expenditure of treadmill and overground walking.*represents significant difference ($p < 0.05$).

CONCLUSIONS

The kinematics data of treadmill and overground walking were very similar. EE of treadmill walking was significantly greater when measured on the overground. It seemed to be the increased stress during the gait by the continuous movement of the belt. As the velocity increased, there was significant difference between actual EE and calculated EE by treadmill due to EE curve increasing exponentially. Therefore the further study would be required to find the correlation of the two methods and calibrate the values from them.

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