Energy Expenditure during Walking, Jogging and Running in Bare and Shod Conditions

Junichiro Yamauchi[1,2,3], Hideaki Koike[1] and Keiji Koyama[4]

[1]Tokyo Metropolitan University, Tokyo, Japan
[2]Future Institute for Sport Sciences, Tokyo, Japan
[3]Faculty of Associated Medical Sciences, Khon Kaen University, Khon Kaen, Thailand
[4]Toin University of Yokohama, Kanagawa, Japan

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Abstract: This study was to compare between barefoot and wearing running shod conditions on energy expenditure during walking, jogging and running. Healthy young individuals performed walking (4km/hr), jogging (8km/hr) and running (12km/hr) on the treadmill in barefoot (BARE) and shod (SHOD) conditions. Respiratory gas analysis was performed using a computerized metabolic measurement cart on a breath-by-breath mode. Exercises with a shod condition were significantly higher energy expenditure than those with a barefoot condition in walking, jogging and running.

1 INTRODUCTION

Many people living in developed countries in modern era wear shoes when they have walking, jogging, running and daily activities. However, over the long period, humans do not use footwear after they became an upright bipedality. Through the evolutional processes of human, the human foot naturally adapts to bear body weight through the daily activities over years. It is considered that the human foot is anatomically designed to live with a barefoot in bipedal locomotion.

Recently, the effects of barefoot running receive a lot of attention to sports scientists (Jungers 2010). Lieberman et al.(2010) shows that running with barefoot reduces impact force when contacting the ground and repetitive stress to the legs. Running with barefoot uses natural shock absorbers of the foot arches, Achilles tendons (ankle joints), and lower legs (knee joints) by landing with forefoot; while, running with shoes allows you to land heel first due to the padding of modern shoes which may increase stride length, and to go up impact force to the legs. Therefore, it can be speculated that running with a barefoot have better energy usage as compared to a shod condition because of the shock absorber function of the foot.

2 PURPOSE

This study was to compare between barefoot and wearing running shod conditions on energy expenditure during walking, jogging and running.

3 METHODS

Subjects
Healthy young individuals (age, 21.6±0.5 years; mean±SD) participated in this study. The methods and all procedures used during this experiment were in accordance with current local guidelines.

Experimental procedure
Healthy young individuals performed walking (4km/hr), jogging (8km/hr) and running (12km/hr) on the treadmill in barefoot (BARE) and shod (SHOD) conditions.

Running shoe was 308.5g. Each exercise was performed for three minutes in random order with sufficient time for recovery between trials.

Measurements
Oxygen consumption (VO2): Respiratory gas analysis was performed using a computerized metabolic measurement cart on a breath-by-breath mode (AE-310, Minato Medical Science, Osaka). The subject wore a mask that enclosed both the mouth and the nose for the entire protocol. VO2 was averaged for the last 2 min of the rest, and for the 1 min 45 sec after 1 minute of the exercise periods. Relative VO2 (ml/kg/min) was calculated and used for analysis.

Heart rate (HR): HR was measured using a heart rate monitor (FT4, Polar FT, Kempele). The device consisted of a sensor strip worn comfortably onto the skin at the chest level. The sensor strap detected the electrical impulses of the heart and transmitted the information to the watch, displaying HR beats per minute. HR was measured every 1 min throughout the experiment.

The rating of perceived exertion (RPE): RPE was assessed by the Borg scale (Borg, 1982). It is a ratio scale that assesses the participant subjective level of exertion ranging from 6 to 20, where 6 was 'no exertion at all' and 20 was 'maximal exertion'. Subjects marked a number that most closely represented their level of physical exertion during exercise. RPE was measured every 1 min throughout the experiment.

Data analysis

All data are presented as means±S.D. The differences in all parapeters between BARE and SHOD were tested using a paired t-test. The level of statistical significance was set at $p < 0.05$.

4 RESULTS

Relative VO2 (ml/kg/min) for BARE and SHOD were 11.28±1.95 and 12.22±1.54 in walking, 27.87±4.54 and 29.59±3.13 in jogging, and 39.89±5.18 and 41.1±4.96 in running, respectively. These differences represent 9.6±11.4%, 7.4±9.1% and 3.2±4.9% of a barefoot condition in walking, jogging and running, respectively, and exercises with a shod condition were significantly higher energy expenditure than those with a barefoot condition. RPE was not significantly different between the two conditions.

5 CONCLUSIONS

These results suggest that wearing running shoes may cost higher energy expenditure than a barefoot condition in walking, jogging and running.

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