Research Article

Effect of forward and backward walking on aerobic capacity and endurance

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Abstract

Aim of the study: Which way of walking, Backward v/s Forward is more optimum to attain more Heart rate (HR) and desired Heart rate maximum (HR max) at lesser speed and lesser grade of treadmill walking. **Objective:** To compare the difference in heart rate when walking forward and walking backward at 5% grade and at a speed of 4 km/hr and to compare the mean Heart rate maximum of both forward and backward walking. **Methodology:** 10 subjects were made to walk on treadmill at 0% grade at 2 km/hr for 3 minutes. Then the grade is increased to 5% and speed to 4 km/hr. The subject was asked to walk for 6 minutes period. At the end of 6 minutes the subject is asked to hold the sensor and the Heart rate is recorded and HR max is calculated after the completion of forward and backward walking. **Results:** Using 't' test (15.365) a statistically significant difference found between Heart rate of Forward walking and Backward walking. Percent Heart rate maximum of backward walking [73.23%] attained percentage heart rate maximum as prescribed by "American College of Sports Medicine Guidelines" and it is significantly more than forward walking [58.07%]. **Conclusion:** Backward walking on a treadmill at 4 km/hr and a grade of 5% elicits greater percent Heart rate maximum than forward walking under the same conditions, expected to improve aerobic endurance.

Key Word: Forward/Backward walking, HR max, aerobic capacity.

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Received Date: 19/05/2014 Accepted Date: 05/06/2014

Access this article online	
Quick Response Code:	Website: www.statperson.com
	DOI: 05 June 2014

INTRODUCTION

Physical exercise is important for maintaining physical fitness and can contribute positively in maintaining a healthy weight, building and maintaining healthy bone density, muscle strength, and joint mobility, promoting physiological well-being, reducing surgical risks, and strengthening the immune system. Vigorous exercise (90–95% of VO_2 Max) is more beneficial than moderate exercise (40 to 70%) of VO_2 Max. Walking has long been used by both rehabilitation and fitness professionals to help in improving cardio-vascular fitness and to rehabilitate musculoskeletal injuries. Because of its functionality, most walking studies and clinical protocols have involved forward walking. However, since 1980's there has been increased interest in studying the benefits of backward walking also referred as retropulsion. The earliest studies explored biomechanics of backward walking using cinematography and electromyography to describe the involvement in backward walking. Subsequent kinematic and electromyographic studies provided a more complete understanding of the backward gait cycle. More recently, investigators have studied the cardiovascular and metabolic cost of backward walking; numerous studies have documented the cardiovascular and metabolic benefits of backward walking. Heart rate and oxygen consumption have been shown to be higher during backward walking than forward walking at treadmill. According to "American college of sports medicine guidelines'' exercise needs to be maintained at an intensity of 60% to 90% maximum heart rate [HR_{max}] to sustain or improve cardiovascular fitness. Backward walking is able to achieve these levels of cardiovascular activity at lower speeds. When compare to forward walking, backward walking has been used as component

How to site this article: Ashwini A. Kale, Sunita D. Chavan. Effect of forward and backward walking on aerobic capacity and endurance. *International Journal of Recent Trends in Science and Technology* June 2014; 11(2): 176-179 http://www.statperson.com (accessed 05 June 2014).

of rehabilitation for many lower-extremity injuries and for injury prevention. Flynn and Soutas-Little reported that backward walking could decrease patellofemoral joint compressive forces. This decrease may prove beneficial in treating patients with patellofemoral dysfunction. Backward walking achieving cardiovascular fitness in lower speed and lower compressive forces as compared to forward walking could decrease injury potential for people understanding of knee injuries. The purpose of this study was to determine the cardiovascular effects of forward versus backward on heart rate at treadmill grade of 5% and at a speed of 4 km/hr and comparison between backward and forward walking in meeting the heart rate maximum prescribed by "American college of sports medicine guidelines''

MATERIALS AND METHODS

Before implementing the study, an approval from ethical committee was taken. The study was carried out in gymnasium. Subjects were explained the procedure and duration of study and verbal and written consent were taken. Inclusion criteria for the study were 10 healthy males (for convenience) with age group of 20 to 25, and who attained the HR max. And the exclusion criteria was subjects suffering from the Cardiac problems, Metabolic problems, Systemic problems, Orthopaedic problems and Subjects who were not able to attain HR max. The program schedule consisted of three sessions separated by at least by two days. First session to familiarize the subject with forward and backward walking and to collect datas of height, weight, age and heart rate. Second session for collecting data of heart rate during forward walking in 5% grade of inclination and speed of 4km/hr. Third session for collecting data of heart rate during backward walking in 5% grade of inclination and speed of 4km/hr.

PROCEDURE

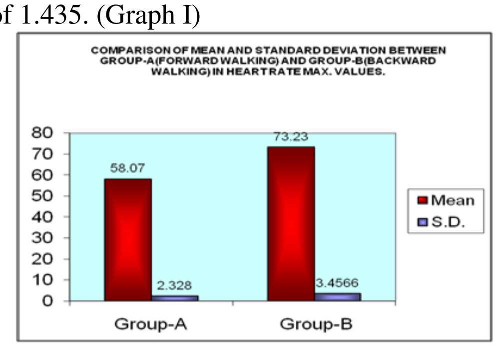
Subjects performed 3 sessions of exercise, separated by at least 2 days to minimize the contribution of muscle soreness and fatigue, which could be influenced in subsequent test leading to error in the study. TAEHA treadmill, which is fully electronic, was selected for the study, which is provided with electronic sensors. If the subject holds the sensor it displays the heart rate. The grade and speed of walking can be selected and it was displayed on the screen. An initial pre-test session served to familiarize the subject with forward and backward treadmill walking and to determine the ability of subject to attain heart rate maximum. The subject was explained about the experiment and procedures involved in it. The age, height and weight of the subject were then recorded. The subjects were asked to walk in forward direction and to attain heart rate maximum in his self selected speed. All the 10 subjects were able to attain the heart rate maximum and they are included in the study. Then they were allowed to take rest until they were ready for practice session. Then subjects began a practice session on treadmill consisting of both forward and backward walking at self selected speed. The practice session continued until the subject felt comfortable with motor co-ordination in each direction of walking. Then subject returned to experiment for second time at least 2 days after the practice session and was assigned to perform forward walking. The test began with the warm-up phase, in which the subject is made to walk on treadmill at 0% grade at 2 km/hr for 3 minutes. Then the grade was increased to 5% and speed to 4 km/hr. The subject was asked to walk for 6 minutes period. At the end of 6 minutes the subject was asked to hold the sensor and the heart rate was recorded. Then again the grade was decreased to 0% and the speed to 2 km/hr and the subject was asked to walk for 3 minutes and the test was finished. The third time subject returned at least after 2 days and assigned to perform backward walking. The test began with the warm-up phase, in which the subject was made to walk backward on treadmill at 0% grade at 2 km/hr for 3 minutes. Then the grade was increased to 5% and speed to 4 km/hr. The subject was asked to walk backward for 6 minutes period. At the end of 6 minutes the subject was asked to hold the sensor and the heart rate was recorded. Then again the grade was decreased to 0% and the speed to 2 km/hr and the subject was asked to walk for 3 minutes and the test was finished. The evaluation of parameters was the Heart rate measured with sensor and the HR max calculated by the formula [220-age]. Then heart rate of every subject was calculated both in forward and backward walking at the end of 6 minutes. The percent HR max was calculated by

$$\frac{\text{Heart rate attained by subject}}{\text{Heart rate maximum}} \times 100$$

The average of HR max, HR and percent HR max were calculated and compared.

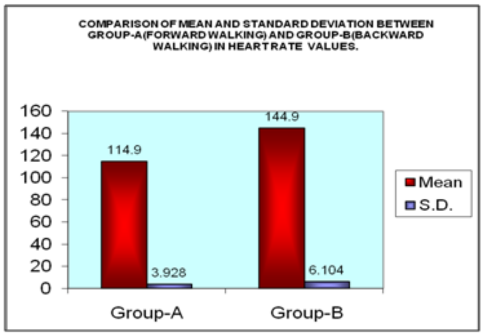
RESULT AND STATISTICAL ANALYSIS

The collected data was tabulated and analyzed using T-test statistics. Heart rate of Forward walking with Mean = 114.9 and S.D. =3.7269. Backward walking values with Mean =144.9 and S.D. =6.0876. Backward walking values are greater than the Forward walking values with Standard Error of 1.435. (Graph I)



Graph I: Comparison of HR between Forward walking (Group-A) and Backward walking (Group-B) using 't' test

The test showed that there Backward walking is more significant than the Forward walking. So the heart rate attained by subjects in backward walking is more than forward walking in same 5% grade and speed of 4km\hr.
Graph II reveals that heart rate maximum of Forward walking with Mean = 58.07 and S.D. = 2.328. Backward walking values with Mean = 73.23 and S.D. = 3.4566. Backward walking values are greater than the Forward walking values with Standard Error of 1.3178.



Graph II: Comparison of HR Max between F(GROUP-A) Forward walking and Backward walking (Group-B) using T-test

The t-value (11.504) shows that there is statistically significant difference at P<0.05 level, between Forward walking and Backward walking, using T-test.
The test shows that heart rate maximum of Backward walking is more significant than the Forward walking. So the average percent heart rate maximum of forward walking [58.07%] failed to meet percentage prescribed by "American college of sports medicine guidelines'' [which says 60% - 90% need to sustain or improve cardiovascular fitness].Percent heart rate maximum of backward walking [73.23%] attained percentage heart rate maximum prescribed "American college of sports medicine guidelines'' and it is significantly more than forward walking.

DISCUSSION

This study report says that a significant increase in heart rate and HR max found. Forward walking (5%) the average HR max is 58.03 %. For Backward walking (5%) is 73.23%. The t-value (15.365) shows that there is statistically significant difference at P<0.02 levels, when comparing heart rate of forward and backward walking. Several reasons have been suggested to explain the increased heart rate during backward walking. Novel tasks may require larger number of motor units to be recruited, which causes increased energy utilization. Alteration of stride length and frequency may be a likely reason for increased heart rate, as stride length is shorter during backward walking as compared to forward walking. The muscle force is also decreased, leading to less energy efficient activity during backward walking. ATP requirements are more during concentric muscle activity than with eccentric contractions. In backward working quadriceps goes for concentric work in most of the range but in forward walking the quadriceps does less concentric work than in backward walking. Higher blood lactate concentration occurs with backward walking as compared to forward walking. The results of present study indicate that backward walking at 4 km/hr at 5% grade met the "American college of sports medicine guidelines" for maintaining or improving cardiovascular fitness. The ability of backward walking, to achieve these specified cardiovascular intensities at lower speeds and at a lower grade compared to forward walking specifies its importance to decrease injury potential. With respect to relevance of backward treadmill walking in rehabilitation of lower extremity injuries, it has been suggested that there is less patellofemoral compression in backward walking than forward walking. This characteristic may lead to suggest backward walking for rehabilitation for patellofemoral pain, infra patellartendonitis, anterior cruciate ligament reconstruction

CONCLUSION

Backward walking on a treadmill at 4 km/hr and a grade of 5% elicits greater percent heart rate maximum than forward walking under the same conditions, and incorporated into sustained training regimens, would be expected to improve aerobic endurance. Clinically can use this information to develop protocols to maintain or improve aerobic endurance of patients utilizing the biomechanical benefits of backward walking.

ACKNOWLEDGEMENT

I sincerely acknowledge my deep sense of gratitude and hearty thanks to the Principal, MGM's Institute of Physiotherapy, Aurangabad for his co-operation throughout the study. And also many thanks to the MGM's Hospital and Research center, Aurangabad and to the subjects participated in this study enthusiastically.

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Source of Support: None Declared
Conflict of Interest: None Declared