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Myocardial Workload and Fat Oxidation in Walking Versus Cycling by Overweight and Hypertensive Adult Males

Manoj Khattri[1], Suresh Singh[2*], Rahul[3], Arya Desh Deepak[4], Mayank Agarwal[5]

[1]Assistant Professor, Department of Medicine; [2]Assistant Professor, Department of Pathology; [3]Associate Professor, Department of Physiology; [4]Principal; [5]Assistant Professor, Department of Physiology, Autonomous State Medical College, Pratapgarh, Uttar Pradesh, India.

ABSTRACT

Background: *The fast-paced increase in the prevalence of obesity and hypertension in India is burdening the country with non-communicable diseases that include cardiovascular disease. Exercise is a primary intervention to manage obesity and hypertension. Treadmill and stationary cycle are the most common form or modalities of indoor exercise adapted by individuals. The modality of exercise causing higher fat oxidation at a lesser myocardial workload should be preferred. The objective of the study was to compare the rate pressure product (RPP, a correlate of myocardial workload) and respiratory exchange ratio (RER, lower value indicates a higher contribution of fat oxidation to total energy expenditure during exercise) in treadmill walk with stationary cycling.*
Methods: *The present crossover study involved twelve, overweight, hypertensive, and physically inactive adult males. The participants exercised for thirty minutes on the treadmill and stationary cycle with a target energy expenditure of 180 Kcal. Systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) were recorded by an automated blood pressure monitor, and RPP in arbitrary unit (AU) was calculated as SBP×HR÷100. Respiratory gas exchange analysis determined the volume of oxygen consumed (VO_2) and carbon dioxide produced (VCO_2). RER was calculated as $VCO_2 \div VO_2$. Student t-test was applied and $P \leq 0.05$ was considered significant.*
Results: *SBP, HR, RPP, and RER was significantly higher in cycling (160.4±4.5 mmHg, 131.9±7.1 beats per minute, 211.4±8.6 AU, and 0.88±0.04) than the treadmill walk (158.4±4.9 mmHg, 129.6±7.6 beats per minute, 205.3±10.9 AU, and 0.86±0.03).*
Conclusion: *Treadmill walk resulted in lesser myocardial workload and higher fat oxidation than cycling.*

Keywords: *Exercise, Fat Oxidation, Myocardial oxygen demand, Respiratory Exchange Ratio, Rate Pressure Product*

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***Corresponding Author**

Dr. Suresh Singh
Department of Pathology, Autonomous State Medical College, Pratapgarh, Uttar Pradesh, India
Email: sureshsingh2017@gmail.com

INTRODUCTION

Obesity has become a global pandemic that can be better termed as 'globesity'.[1] The prevalence of obesity in India is rising at an alarming rate that is faster than the world's average.[2] In the past decade, the obesity prevalence in India has doubled, making India the third most obese country in the world.[3, 4] This fast-paced growth in obesity prevalence has increased the burden of non-communicable diseases. Obesity alone is a significant cause of high blood pressure, and in combination with hypertension is recognized as an eminent cause of cardiovascular disease.

Among various risk factors for global mortality, physical inactivity occupies the fourth position.[5] Almost half of the adult population in India are physically inactive. Only about ten percent Indian population engage in recreational physical activity.[6] Physical inactivity ultimately leads to visceral fat accumulation and chronic systemic inflammation causing non-communicable diseases, including cardiovascular disease.[7]

Early intervention including lifestyle modification, particularly weight management, could prevent the development of cardiovascular disease in individuals with hypertension and obesity. Exercise is one of the best ways to manage obesity and hypertension.[8] Stationary cycling and brisk walking on the treadmill are the most familiar mode of indoor exercise adapted by individuals. A few previous Indian studies on

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healthy adults have shown that treadmill walking is more beneficial for greater fat oxidation with lesser myocardial oxygen demand.[9-11] There is a paucity of data regarding the cardiovascular response and relative fat oxidation induced by walking and cycling in obese and hypertensive adult males. Hence, the current study aims to calculate/record the myocardial workload and fat oxidation in physically inactive, overweight, and hypertensive adult Indian males.

METHODS

The present crossover study was started after obtaining Institutional ethical clearance at the Exercise Physiology laboratory, King George Medical University (KGMU), Lucknow, Uttar Pradesh (UP), India. All participants signed the written informed consent.

G-power v3.1.9.7 estimated that at 5% alpha error and 80% power of the study, nine participants were required to detect a mean change of 5% with a standard deviation of 10% in a two-tailed student t-test considering 0.90 correlation between the group.[12]

Twelve adult males having body mass index (BMI) of 23-24.9 kg/m^2 (Asia Pacific classification) and SBP of 130-139 mmHg or DBP of 80-89 mmHg (American College of Cardiology / American Heart Association 2017 criteria of stage 1 hypertension) were recruited in the study.[13, 14] The General Practice Physical Activity Questionnaire was used to determine the physical inactiveness of the participants.[15]. The Physical Activity Readiness Questionnaire for Everyone determined that the participants can perform physical activity without adverse events.[16] The exclusion criteria were abnormality detected during systemic examination, a recent history of substance abuse, and/or inability to follow exercise protocol.

BMI was calculated as weight (kg) ÷ height (m^2). A locally available electronic weighing machine and stadiometer determined the weight and height of the barefoot participants wearing light clothing.

Two familiarization sessions were conducted before the actual test so that the participants get accustomed to the proper usage of the treadmill and cycle ergometer. Total energy expenditure is more important than the intensity of exercise for the improvement in cardiovascular health.[17] Hence, a target energy expenditure of 180 (±9) Kcal was set for the thirty minutes of steady-state walking on the treadmill and pedalling the stationary cycle 180 Kcal energy expenditure for six days will amount to approximately 1000 Kcal/week that is recommended for physically inactive individual.[18] On the test day, participants arrived at the exercise physiology laboratory after at least six hours of fasting and 24h abstinence from energy-laden food, beverages, cardiac stimulants like tea, coffee, and carbonated soft drinks or energy drinks having caffeine. Participants first exercised either on the treadmill or the cycle ergometer as per their choice, followed by a rest period of 15 days. Thereafter, participants performed the other modality of exercise. A one-day food diary was maintained, and participants were instructed to replicate the 24h meal before each test session (i.e., before the treadmill test and before the cycle ergometer test). The test was done from 3 to 4 PM. SBP, DBP, and HR were recorded by an automatic blood pressure monitor (Omron HEM 7130-L, Kyoto, Japan) immediately before and after the exercise, following the criteria mentioned by American Heart Association. RPP is the best non-invasive linear correlate of myocardial oxygen demand or workload. RPP was calculated as — SBP×HR÷100.[19] RPP reactivity, SBP reactivity, DBP reactivity, and HR reactivity in percentage was calculated as — [(value of the parameter after exercise - resting value of the same parameter) ÷ resting value of the same parameter] × 100.

Respiratory gas exchange analysis was done during the last two minutes of the exercise session by the ADInstruments exercise physiology system. RER indicates the relative contribution of carbohydrate and fat/lipid oxidation for energy production during the exercise. The higher RER value indicates more a significant contribution of carbohydrates to total energy expenditure during exercise. Lower the RER value, greater the contribution of lipids or fat to total energy expenditure. RER was calculated as $VCO_2 \div VO_2$.[20]

Statistical analysis was done in IBM SPSS statistics (version 26.0 for Windows, IBM Corp., Armonk, NY, USA). Data are presented as mean ± standard deviation (SD). Student (paired) t-test was applied, confidence interval was 0.95, and $P \leq 0.05$ was considered statistically significant.

RESULTS

The table 1 represents the anthropometric characteristics of the participants. Participants were overweight having stage 1 hypertension. Table 2 represents that the study parameters before either exercise modality (treadmill and stationary cycle) were similar. Table 3 shows that the SBP, HR, RPP, RER were significantly higher, while DBP was not significantly different after the stationary cycling than the treadmill walk. VO_2 after treadmill walk and stationary cycling was similar representing that in both the modalities of exercise energy expenditure was the same. 1 L/min of O_2 consumption amounts to 5 Kcal, so 1.23 L/min O_2 consumption for thirty minutes will provide approximately 185 Kcal.[21] Table 4 shows that the SBP reactivity, RPP reactivity, and HR reactivity to stationary cycling were significantly higher than the treadmill walk. DBP reactivity to stationary cycling and treadmill walk was similar.

Table 1: Anthropometric characteristics of the participants.

Parameters	Mean ± SD
Height (cm)	166.9 ± 3.3
Weight (Kg)	67.3 ± 2.7
BMI (Kg/m^2)	24.1 ± 0.5
Age (y)	27.3 ± 3.6

Table 2: Comparison of study parameters before the treadmill walk and stationary cycling.

N=12	Before treadmill walk	Before stationary cycling	P
SBP (mmHg)	134.8 ± 2.8	134.7 ± 2.5	0.820
DBP (mmHg)	86.0 ± 3.1	85.9 ± 3.0	0.754
HR (beats per min)	77.2 ± 7.6	77.3 ± 7.1	0.889
RPP (AU)	103.9 ± 9.7	104.1 ± 9.7	0.850
RER	0.82 ± 0.03	0.82 ± 0.03	0.777

Table 3: Comparison of study parameters after the treadmill walk and stationary cycling.

N=12	After treadmill walk	After stationary cycling	P
SBP (mmHg)	158.4 ± 4.9	160.4 ± 4.5	0.036
DBP (mmHg)	89.4 ± 4.5	89.9 ± 4.4	0.111
HR (beats per min)	129.6 ± 7.6	131.9 ± 7.1	0.034
RPP (AU)	205.3 ± 10.9	211.4 ± 8.6	0.012
RER	0.86 ± 0.03	0.88 ± 0.04	0.021
VO_2 (L/min)	1.23 ± 0.02	1.23 ± 0.02	0.674

Table 4: Comparison of cardiovascular reactivity after treadmill walk and stationary cycling

N=12	Treadmill walk	Stationary cycling	P
SBP reactivity	17.6 ± 3.9	19.2 ± 3.7	0.027
DBP reactivity	4.0 ± 3.3	4.8 ± 3.4	0.085
HR reactivity	68.7 ± 8.8	71.5 ± 9.9	0.028
RRP reactivity	98.6 ± 14.3	104.4 ± 15.8	0.007

DISCUSSION

The present cross-section quasi-experimental study was conducted on overweight, hypertensive and, physically inactive adult males. The study aimed to compare the myocardial workload and contribution of fat oxidation to the total energy expenditure in treadmill walking with stationary cycling. The study results indicate that at isocaloric exercise, treadmill walk induced greater fat oxidation with lesser myocardial workload than stationary cycling.

It is difficult to compare the present study results directly with the previous studies because of differences in exercise protocols, measurement techniques, and subject characteristics. Still, the cardiovascular response obtained in the present study is in close agreement with the results from Grant et al., who reported that at given oxygen cost, the SBP, HR, and RPP were higher for cycling than the treadmill exercise done by male subjects.[22] Lafortuna et al. reported higher HR in cycling than treadmill walk at similar energy consumption.[23] Reed et al. reported a higher SBP response to cycling than treadmill walk.[24] Kim et al. reported higher RPP in cycling than treadmill walk.[25] Esco et al. postulated that cycling causes greater sympathetic stimulation and delayed parasympathetic reactivation than walking which could be a cause of heightened cardiovascular response to cycling as obtained in the present study.[26]

In agreement with the present study results, few previous studies have reported that treadmill walk induces greater fat oxidation as compared to cycling. However, the exact mechanism is still not known. Sharma et al., Zakrzewski and Tolfrey, and Lafortuna et al. reported that at isocaloric exercise, treadmill walk results in greater fat oxidation than stationary cycling.[10, 27, 28]

The crossover design of the present study has streamlined the chances of confounders; still, there were few limitations. The sample size could not be increased due to resources and time limitations. The present study results are qualitative rather than quantitative due to the involvement of correlates of fat oxidation and myocardial workload in the form of RER and RPP respectively. It might be possible that the participants were more accustomed to walking than cycling that could have resulted in better cardiovascular adaption to the former mode of exercise.[29] Due to these limitations, the data of the present study require external validity.

The results of the present investigation might be helpful in the formulation of the physical activity protocols to be delivered in a clinical context as a form of exercise treatment for obesity in hypertensive individuals having less tolerance to cardiovascular exertion.

CONCLUSION

The data from this crossover study involving hypertensive, overweight, physically inactive adult males revealed a significantly higher fat oxidation while a significantly lower myocardial workload in an acute bout of treadmill walking than stationary cycling for thirty minutes at a similar energy expenditure of approximately 185 Kcal.

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