ORIGINAL ARTICLE

CONSEQUENCES OF BRISK WALK, MODERATE INTENSITY CONTINUOUS AND HIGH INTENSITY INTERVAL TRAINING ON SHORT-TERM HEART RATE VARIABILITY IN HEALTHY YOUNG ADULTS

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Background: Short term heart rate variability is a time saving non-invasive measure of autonomic nervous system dysfunction. This study was conducted to assess and compare the effect of walking, medium intensity continuous and high-intensity interval training exercise modalities on short-term heart rate variability. **Methods:** This experimental study was conducted at the Department of Physiology, Islamic International Medical College, Rawalpindi, from August 2018 to August 2019. A total of 31 non-obese, healthy young individuals, free of comorbidities were included in the study. Participants were assigned through randomization to walk for 30 minutes intervention (n=10), medium intensity continuous training (MICT) intervention (n=11) and high-intensity interval training (HIIT) intervention (n=10). Intervention groups completed a total of 24 sessions in 7 weeks. Heart rate variability (HRV) analysis was performed by a 15-minute ECG recording before and after 24 sessions of intervention. ECGs were recorded by using the PowerLab® model 4/25T and the data were analysed using the software LabChart® Pro-8.0 with HRV 2.0 module installed. **Results:** After 24 sessions of 30-minute brisk walking exercise of 3,000 steps in an open area revealed a significant improvement in some HRV components when compared with pre-intervention levels of mean R-R interval (p=0.02), LFms2 (p=0.02) and LF/HF ratio (p=0.03). No significant differences were recorded after MICT and HIIT interventions among the groups. **Conclusion:** Compared to MICT and HIIT, a brisk walk in an open area was found to be effective mode of physical activity for improvement of HRV.

Keywords: High-intensity interval training, HIIT, Exercise Training, Walking

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INTRODUCTION

A sedentary lifestyle is a risk factor for obesity and cardiovascular problems. In Pakistan 17.5% of the population is suffering from cardiovascular diseases (CVD).[1] Decreased physical activity is associated with an increased risk of death from CVD[2], and 60% of the Pakistani population lead a physically inactive lifestyle![3]

There are multiple ways to increase the daily physical activity levels; one simple and safe choice is to do a brisk walk in an open area place.[4,5] Apart from that, people can indulge in medium-intensity indoor cycling for 30 minutes which has shown promising effects.[6] However, another technique that has shown benefits, is to perform high-intensity interval cycling training.[6,7]

One of the ways to assess the CVD risk factor is through determining the sympathovagal balance of the heart, which can easily be assessed by recording heart rate variability (HRV). Heart rate variability is a well-established tool for assessing patients at risk of heart diseases and their related deaths.[8]

HRV is considered as a 'gold standard' to assess cardiac autonomic functioning (CAF).[9] Higher/ improved HRV is generally regarded as an indicator of improved CAF. Many studies have pointed out that reduced CAF (i.e., lower time-domain and/or impaired frequency-domain HRV) is associated with higher risks of adverse cardiovascular outcomes and all-cause mortality.[10] HRV is increased in response to exercise training with an increase in resting levels of a parasympathetic drive of the heart in physically active individuals.[11] Researchers have demonstrated the association of HRV with a brisk walk[12], medium intensity continuous training (MICT)[13], and with high-intensity interval training (HIIT)[14] as a mode of physical activity. Nevertheless, insufficient data are supporting the most effective model among these, for improvement in HRV in healthy non-obese young adults.

Given the association between HRV and various health markers, further investigation into modifiable factors that can potentially improve HRV is warranted. Performing more physical activity is a potential lifestyle intervention that individuals can adopt to improve HRV, although how factors such as types of physical activity (PA) affect cardiac autonomic function particularly among individuals of local descent requires further investigation. The current study aimed to examine and compare the effect of the 30-minute brisk walk, medium-intensity continuous and high-intensity interval training exercise on HRV in a medical college students of Rawalpindi, Pakistan. It was hypothesized that participants who performed high intensity interval training cycling exercise would exhibit better levels of HRV compared to age and body composition-matched inactive participants, medium intensity continuous cycling and 30-min brisk walk groups.

SUBJECTS AND METHODS

This was a randomized control study to examine and compare the heart rate variability in different modalities of physical activity, conducted at Department of Physiology, Islamic International Medical College from Aug 2018 to Aug 2019. HRV parameters were dependent variables and the type of PA were independent variables. Approval from the Ethical Review Committee and Board of Advanced Studies and Research, Islamic International Medical College, Riphah International University, Islamabad was obtained. Participants were recruited from Islamic International Medical College, Islamabad after informed consent.

A total of 41 healthy nonsmoker participants with mean age 20.2±0.9 years and BMI ≤29 were included using nonprobability convenience sampling. Subjects having infectious disease, musculoskeletal, cardiovascular, metabolic and respiratory disorders, medical conditions associated with altered autonomic function (e.g., arrhythmia and valve defects) and use of psychotropic medication were excluded.

The participants were randomized through balloting and were divided into 4 groups namely Group A (High intensity interval training group, n=10), Group B (Medium intensity continuous training group, n=11), Group C (Brisk walk group, n=10), and Group D (Control group, n=10). The training intervention protocol was developed and modified from previous studies[15]:

Group A participants were instructed to install 'pacer' applications on their mobile phones and complete 3,000 steps in 30 minutes at any time of day in an open area. Walking with at least 100 steps per minute speed is considered a medium intensity exercise.[16] Each participant sent a screenshot of the pacer application from their mobile phones for record, following completion of the exercise session which shows number of steps, time duration of walk, calories burnt, location and complete map of track used for walk.

Group B performed 30-minute continuous static cycling exercise at the intensity of 60–75% of HR_{max} (220 - Age in years)[17] per session. Their heart rate was monitored every 5 minutes using the exercise bike's heart rate monitor as well as manually by palpation of the radial pulse. Manually counted heart rate was considered if there was a discrepancy between the two methods.

Group C performed cycling for 20 minutes[15] per session. Each minute is divided into two phases: 20 seconds active and 40 seconds recovery phases. During the active phase, subjects performed an all-out sprint at the speed of 100 RPM or higher and decreased to lower than 50 RPM during the recovery phase.

Group D didn't participate in any physical activity and lived a sedentary lifestyle, based on history and International physical activity questionnaire (IPAQ 2002) filled by each participant.

Each participant had to complete 24 total sessions under supervision in a total of 7 weeks at physiology lab of Islamic international medical college, Rawalpindi. Both group B and C were instructed to have their meal at least 2 hours before exercise, and their interventions were done under supervision to take care of any possible complications. Both groups used the exercise bike model 'Slimline prestige 450BP' and performed 5 minutes cycling warm-ups, and 5 minutes are cycling cooldowns at low intensity (40% HR_{max}) during each visit, before and after their respective exercise intervention as a part of the intervention protocol. The exertion level was continuously monitored according to the Omni scale. The test terminated if the participant perceives level 8 or above on the Omni scale.

ECG of each subject lying in a quiet and slightly lit room obtained before and after a total of 24 sessions of intervention, 15-minute ECG was recorded using PowerLab® model 4/25T (ADInstruments (Sydney) Pty. Ltd.). Five minutes ECG data, which was free of artefact and ectopic beats, were analyzed for HRV using LabChart Pro version 8.0 software with HRV 2.0 module installed.

Data analysis was performed on SPSS-26. Results were represented as Mean±SD. Paired sample *t*-test was applied for the comparison of means before and after the intervention exercise in each group. Analysis of variance (ANOVA) was used for comparison between the groups and $p \leq 0.05$ was considered statistically significant.

RESULTS

All participants were students of Islamic International Medical College. Out of the total of 41 students, 17 (41.5%) were male and 24 (58.5%) were female. Demographic data of the subjects is given in Table-1.

Table-2 shows the HRV changes after walk in Group A. After 24 sessions there was a significant increase in mean R-R interval from 762.0±133.2 mS to 788.8±149.3 mS (p=0.02), decrease in absolute power of low frequency band ($LFmS^2$) from mean 1403.3±1156.7 mS^2 to 668.8±461.9 mS^2 (p=0.02), decrease in LF/HF from mean 2.5±2 to 1.2±0.5 (p=0.03), increase in SD of interbeat interval (SDNN) from mean 56.4±26.9 mS to 57.5±20.6 mS (p=0.88), increase in root mean square of successive differences (RMSSD) from mean 43.2±29.3 mS to 43.8±25.6 mS (p=0.79) and decrease in absolute power of high frequency band ($HFmS^2$) from mean 1067.8±1439.7 mS^2 to 818.9±914.5 mS^2 (p=0.33).

Table-3 shows the HRV changes in Group B. There was a nonsignificant increase in mean R-R interval from mean 775.4±133.6 mS to 804.3±122.6 mS (p=0.360), increase in SDNN from mean 48.9±22.2 mS to 58.9±17.3 mS (p=0.141), a slight decrease in LF/HF from mean 2.5±3.9 to 1.3±0.98 (p=0.271) and no significant difference in RMSSD, $LFmS^2$, and $HFmS^2$.

Table-4 data shows the HRV changes in the high-intensity interval training (HIIT) intervention group, indicating that after 24 sessions there is a slight increase in SDNN from mean 54.7±18.6 mS to 57.4±17.5 mS (p=0.517), a slight decrease in $HFmS^2$ from mean 1393.6±1521.5 mS^2 to 1049.2±626.1 mS^2 (p=0.303) and insignificant difference in mean R-R interval, RMSSD, $LFmS^2$, and LF/HF ratio noted.

Table-5 data for 'Analysis of variance results showing the difference in the effect of HIIT, MICT, walk intervention and control groups on different HRV parameters' showed when the effect of HIIT, MICT and walk intervention on mean R-R interval, SDNN, RMSSD, $LFmS^2$ $HFmS^2$, and LF/HF ratio are compared between all groups by ANOVA, and it does not show any significant difference.

Table-1: Demographics of study participants

Characteristics	Male (n=17)	Female (n=24)
Age (Year)	20.7±1.6	20.1±0.6
Weight (Kg)	66.8±7.4	56.3±9.6
Height (Cm)	173.6±7.5	163.2±6.3
BMI	22.2±3.0	21.2±3.7
Pulse (bpm)	71.4±10.5	77.8±6.8
Systolic BP (mmHg)	108.8±9.1	107.8±9.6
Diastolic BP (mmHg)	72.0±6.4	71.6±5.7

Table-2: Comparison of heart rate variability parameters in walk group (Mean±SD)

Parameters	Pre-intervention	Post-intervention	*p*
Time Domain Parameters			
Mean R-R intervals (mS)	762.0±133.2	788.8±149.3	0.029*
SDNN (mS)	56.4±26.9	57.5±20.6	0.889
RMSSD (mS)	43.2±29.3	43.8±25.6	0.796
Frequency Domain Parameters			
$LFmS^2$	1403.3±1156.7	668.8±461.9	0.028*
$HFmS^2$	1067.8±1439.7	818.9±914.5	0.329
LF/HF	2.5±2	1.2±0.5	0.036*

*Significant

Table-3: Comparison of Heart rate variability parameters in the MICT group (Mean±SD)

Parameters	Pre-intervention	Post-intervention	*p*
Time Domain Parameters			
Mean R-R intervals (mS)	775.4±133.6	804.3±122.6	0.360
SDNN (mS)	48.9±22.2	58.9±17.3	0.141
RMSSD (mS)	39.8±18.1	44.3±23.1	0.613
Frequency Domain Parameters			
$LFmS^2$	1162.3±1538.1	990.2±738.2	0.686
$HFmS^2$	736.8±548.5	961.7±1097.5	0.561
LF/HF	2.5±3.9	1.3±0.98	0.271

Table-4: Comparison of Heart rate variability parameters in the HIIT group (Mean±SD)

Parameters	Pre-intervention	Post-intervention	*p*
Time Domain Parameters			
Mean R-R intervals (mS)	799.2±94.8	799.8±94.2	0.983
SDNN (mS)	54.7±18.6	57.4±17.5	0.517
RMSSD (mS)	50.1±18.4	51.6±14.4	0.648
Frequency Domain Parameters			
$LFmS^2$	1050.1±1120.7	947.2±658.7	0.559
$HFmS^2$	1393.6±1521.5	1049.2±626.1	0.303
LF/HF	1.1±0.95	0.998±0.660	0.618

Table-5: Analysis of variance results showing the difference in the effect of HIIT, MICT, walk intervention and control groups on mean R-R interval, SDNN, RMSSD, $LFmS^2$, $HFmS^2$ and LF/HF ratio (Mean±SD)

Heart rate variability parameters	HIIT Group	MICT Group	Walk Group	Control Group	*p*
Time Domain Parameters					
Mean R-R intervals (mS)	799.8±94.2	804.3±122.6	788.8±149.3	795.5±94.1	0.992
SDNN (mS)	57.4±17.5	58.9±17.3	57.5±20.6	57.9±19.5	0.997
RMSSD (mS)	51.6±14.4	44.3±23.1	43.8±25.6	49.8±19.6	0.791
Frequency Domain Parameters					
$LFmS^2$	947.2±658.7	990.2±738.2	668.8±461.9	1046±593.3	0.543
$HFmS^2$	1049.2±626.1	961.7±1097.5	818.9±914.5	1027.6±732.5	0.934
LF/HF	0.998±0.660	1.3±0.98	1.2±0.5	1.2±0.5	0.714

DISCUSSION

There is strong evidence in the literature on the improvement of HRV and therefore cardiovascular health in physically active individuals. We found that the walking group revealed improvement in HRV parameters like increased R-R interval and decreased LF, and LF/HF ratio. The results of this study are consistent with an earlier report by Song *et al*[18] documenting the improvement of post-walking intervention HRV parameters. They reported improvements in the frequency domain of HRV, i.e., a decrease in LF, and LF/HF ratio after a 15-minute walk in a park, but they studied the immediate effect on the same day, and the present study has seen the change in resting levels of autonomic balance. Pope *et al*[19] have seen the effect of accelerometer-based medium-intensity physical activity and found non-significant changes in time domain parameters like SDNN and RMSSD for which they supposed that it was due to less time duration of physical activity spent by that particular group.

In both the MICT and HIIT intervention groups, there was no statistically significant improvement in almost all measured HRV parameters. Exercise at moderate intensity levels for 24 sessions improved (Vo_{2max}) by 11% among inactive middle-aged men, but did not rise vagal modulation as measured using HRV.[20] Our findings are in accordance with Leicht *et al*[21] who studied HRV response after 16 weeks of different unsupervised intensities of the subject's choice mode of exercise and observed no significant change in HRV parameters. Moreover, they proposed that there is a vagal critical point, after which it revealed autonomic modulation responses in body. The present study did not show a significant result after seven weeks, even though participants followed cycling exercise protocol under supervision in the laboratory. Factors like duration of the intervention were also hypothesized in a review by Aubert *et al*[22] to explain less effect on HRV parameters.

Contrary to present study results, May *et al*[23] found that HRV time-domain, i.e., RMSSD value is better in young adults involved in vigorous physical activity as a routine when compared with those involved in light-moderate intensities of physical activity in daily life. Another study found that high-intensity interval training at 130% of maximal oxygen uptake (Vo_{2max}) for three weeks improved heart rate variability parameters.[24]

Given that the present study findings can be explained considering the published literature[21,22,25] that HRV improvement is affected by the number of sessions and longer duration of the total intervention period. Thus, 24 sessions of MICT and HIIT over seven weeks seems to be insufficient to assess the effects of exercise on resting autonomic balance. It is indicated that more time and sessions are needed to assess the effect of indoor aerobic exercise on resting levels of the autonomic balance of the heart.

The improvement in LF and LF/HF ratio in the walking group as compared to HIIT and MICT group indicates a better sympathovagal balance after walking intervention. The change of sympathovagal activity (LF/HF ratio) in the walking group might be associated with parasympathetic improvement.[26,27]

Our study is limited in terms of small sample size, limited duration of intervention, and not assessing individual aerobic capacity by measuring Vo_{2max} which could not be assessed due to the unavailability of equipment. Long term experimental studies with larger sample size and adequate number of total sessions with multiple modes of physical activities are recommended.

CONCLUSION

Brisk walk in an open area is the most effective mode of physical activity when compared to medium intensity continuous training or high-intensity interval training to improve the frequency domain of HRV. Large-scale studies are recommended to explore the impact of continuous mild-moderate physical activity on the survival rate of patients with cardiovascular diseases.

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