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Cardiorespiratory responses of ambulatory hemiplegic stroke survivors to treadmill walking exercises in Tehran, Iran

Abstract

Stroke is one of the leading causes of disability and post challenges in the society due to impaired neuromuscular control, decreased functional mobility, balance deficits and reduced cardiorespiratory fitness, and hence physiotherapy interventions can play a significant role in facilitating individuals with impairment, disability and functional limitations. Exercise training among the post stroke population can facilitates improvement in cardiovascular, respiratory and neuromuscular function. However there appear to be a dearth of knowledge and literature on the response of cardiorespiratory parameters of stroke survivors to treadmill walking exercises in Iran. This study was therefore designed to investigate the cardiorespiratory response of ambulatory hemiplegic stroke survivors to treadmill walking exercise. The 32 participants for this study were recruited using consecutive sampling technique, in which 17 were male while 15 were female. An Informed consent and data form were used to obtain the participants' consent and socio-demographic information. The study was a pre and post experimental design involving the participant's own maximum walking ability on the treadmill. The Descriptive statistics of mean and standard deviation were used to describe the participants' demographic and baseline characteristics which were Age, Weight, Height, and Body Mass Index. The inferential statistics of paired t-test was used to compare the cardiorespiratory parameters of the participants' within gender, while unpaired t-test was used for comparison between genders. The level of statistical significance was set at alpha equal 0.05. The result showed that 53.1% of the participants were male while 46.9% were female. The mean age of the participants was 52.37±10.15 years (range of 33-74 years), Mean weight was 68.82±8.6, Mean height was 1.68±0.18 and Mean BMI was 27.71±7.64 respectively. There was a significant difference between male and female participants before and after treadmill walking exercise in their Pulse rate (t=3.19, p=0.006), Systolic blood pressure (t=2.67, p=0.03) and Respiratory rate (t=6.19, p=0.001), except for Diastolic blood pressure which showed no significant difference (t=0.79, p=0.4). Comparison between male and female selected parameters all showed significant difference in their Systolic blood pressure (t=24.38, p=0.001), Diastolic blood pressure (t=9.36, p=0.001) and Respiratory rate (t=15.12, p=0.001) respectively, except for pulse rate which showed no significant difference (p = 0.86, t = 0.17). It was concluded that there was significant increase in the pulse rate, systolic blood pressure and respiratory rate following treadmill walking exercises but changes seen in diastolic blood pressure were not significant. It is recommended that treadmill walking exercise be considered by rehabilitation professionals when developing exercise prescription programs for rehabilitation of ambulatory hemiplegic stroke survivors to optimize the cardiorespiratory benefits associated with exercise. It is also recommended that Rehabilitation professionals encourage people after stroke to participate in exercise interventions such as treadmill walking exercise to improve cardiorespiratory health.

Keywords: cardiorespiratory responses, ambulatory hemiplegic stroke survivors, treadmill walking exercises

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Introduction

Stroke is defined as a rapid developing clinical signs of focal or global disturbances of cerebral function with symptoms lasting for more than 24 hours or leading to death with no apparent non vascular cause.[1] It could be cause by an intracerebral bleeding (intracerebral hemorrhage), occlusion of a cerebral artery (thrombosis or atherosclerotic), embolic and micro artery occlusion[2] or can also be caused by spontaneous rupture of blood vessels, aneurysm or secondary to trauma.[3] Through these causes, it may be classified as either ischemic or hemorrhagic stroke which occur either directly into the brain or into the space surrounding the brain.[4] Symptoms may include headache, weakness of one side of the body, vomiting, seizure, decreased level of consciousness and neck stiffness.[5] Hemiplegic stroke refers to the unilateral paralysis of the entire left or right side of the body.[6] Individuals with hemiplegic stroke usually have difficulties maintaining their balance leading to inability to shift weight making the performance of activity of daily living difficult.[4]

Hemiplegic stroke is one of the leading causes of disability, according to the World Health Organization, 15 million people suffer stroke worldwide, and of these, 5 million are permanently left disabled.[7]

The incidence and prevalence of stroke have not been established in Nigeria, however, a report from a stroke registry in Ibadan gave the annual incidence of stroke in Nigerians as 26/100000 populations.[8] Men are 25% more likely to suffer strokes than women (National Institute of Neurological Disorders, 1999). Physical inactivity has been associated with increased incidence of stroke in both men and women.[9] Stroke may be recurrent (Nearly one-third) and majority of hemiplegic stroke have other coexisting cardiovascular disorders,[10] for instance heart disease is said to be present in the majority of hemiplegic stroke survivors, hence exercises tends to improve and prevent cardiorespiratory disorders.[11]

Regular exercise has a favorable effects on cardiorespiratory health which includes heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure(DBP), pulse oxygen saturation (SPO_2), Respiratory rate(RR) and so on.[12] Exercise programs which enhance cardiovascular health of hemiplegic stroke survivors include walking exercises, bicycle ergo meter, squatting exercise and treadmill walking exercise among others. Treadmill walking exercise is a form of therapeutic aerobic exercise that can be utilized for the management of neurological patients such as hemiplegic stroke survivors'. The treadmill stimulates repetitive and rhythmic stepping while the patient is supported in an upright position and is bearing weight on the lower limbs[13] Exercise programs such as treadmill exercises have been developed as part of post stoke rehabilitation to prevent complications, to decrease the risk of recurrent stroke or cardiovascular events, and to improve cardiorespiratory fitness.[14]

Cardiorespiratory fitness reflects the ability of an individual to carry out large-muscle, dynamic, moderate-to-high intensity exercise over a prolonged period of time.[15] The cardiorespiratory system changes dramatically during exercise when compared to the resting state of an individual. Emerging evidence suggest exercise training among the post stroke population can facilitate improvement in the cardiovascular, respiratory and neuromuscular system.[16] Despite these benefit of treadmill exercises, it is equally important to know the risk associated with this exercise modality and to identify the response of exercise to the selected cardiorespiratory parameters by the different genders. The present study is therefore aimed at investigating the response of some selected cardiorespiratory parameters among female ambulatory hemiplegic stroke survivors following treadmill walking exercise.

Method

Participants

The participants for this study were male and female patients referred and diagnosed as ambulatory hemiplegic stroke to the Department of Nursing, University of Shahid Beheshty and Tehran, Iran. They were volunteer ambulatory hemiplegic stroke survivors who are at least >3 months duration post stroke and regular on Anti-hypertensive drugs. They were of stable psychological status and are well oriented in time place and person. They were patients with no any abnormal cardiorespiratory conditions such as cardiac arrhythmia, myocardial infarction, pulmonary embolism, and were capable of walking at least 6 minutes walk test. Those with musculoskeletal abnormalities such as leap Length discrepancy, fracture and arthritis in the lower extremity which could give an added stress were excluded from this study.

Instruments

The instruments used for data collection for this study included the following;

a. Treadmill walking machine on which walking exercise will be carried out. Model (EN MILL, ETB-04-190).

b. Sphygmomanometer. Model (Kris Alloy) for measuring Blood Pressure.

c. Stethoscope for listening to systolic and diastolic sound.

d. A chair with backrest: to provide comfortable position to patients.

e. A book in which data will be recorded.

f. Weighing scale on which the weight of participant will be measured. model (RGZ-160)

g. Stop watch for timing pulse rate.

h. Tape Measure for measuring participants' Height

Procedures for data Collection

Ethical approval was obtained from the research and ethics committee of the University of Shahid beheshty before commencement of this study. Ambulatory hemiplegic Stroke survivors who met the inclusion criteria were given an informed consent form (Appendix A) to sign and the study was explained and demonstrated adequately to the participants. Before the beginning of the training, the participants were formally welcomed and were seated in a chair with backrest at the site of training for 5 minutes. Prior to test, the patient was asked about symptoms that could contradict the procedure such as chest pains or shortness of breath, and stiff joints from arthritis. The participants were asked to wear comfortable clothing and shoes such as athletic sneakers during the exercise. Their bio-data and demographic characteristics which are age, gender, educational back ground, weight and height was recorded. The participant's pre exercise cardiorespiratory parameters were measured before the beginning of the treadmill walking exercises. The participants started off by warming up at his own speed on the treadmill after which he rest for 5min on self selected speed to the maximum tolerance of that individual without measurement. The maximum walking speed is tested by making that participants walk on a treadmill at a speed commensurate with his maximum ability which is done by increasing the speed 5sec at interval after that the response of the exercise was taken 15 minutes immediately after exercise and was maintained as the maximum speed for every particular participant. The participants were then asked to rest after taking his blood pressure, respiratory rate and pulse rate. The methods in which these parameters were measured include;

Weight measurement

In taking patient weight, the scale was set at zero before the client steps onto them. the patient was asked to remove any 'heavy' items from their pockets (key's, wallets etc) and remove any heavy items of clothing or apparel (big jackets, shoes, woolen jerseys etc) .when measuring weight, patient was asked to look straight ahead and stay still on the scales and wait for the needle/Digital screen to settle before recording the measurement.

Height measurements

Ideally height measurements is taken using a 'drop down' tape measure fixed at about 2 meters on a wall or a specific piece of measuring equipment. A reliable measurement could be taken without this equipment by marking a point (top of clients head) against a wall and measuring up to it. When taking measurements of height, patient was asked to remove his/her shoes prior to taking the measurement and were asked to stand with their back to the wall and look directly forward. The back of their feet, calves, bottom, upper back and the back of their head were all in contact with the wall. Measurement was taken by lowering the measuring device until it rests gently on the top of patient head and records the measurement.

Blood pressure measurement

In measuring blood pressure patient was relaxed, seated upright on a chair with back rest, his upper limb positioned so it is leveled with his/her Heart, feet flat on the floor and excess clothing are being removed with participant's consent. The cuff was wrapped around the patient's arm circumference after palpating for the brachial artery. On the same arm the BP cuff placed, the bell of the stethoscope was placed on the crease of the arm medially and then begins to pump the cuff bulb as the pulse sound was listened and the reading on the gauge was observed. The cuff was then deflated slowly and carefully listening to the sounds, the occurrence of rhythmic sounds heard was the patient's systolic blood pressures, for the patient's diastolic blood pressure, continue to listen until the BP cuff pressure drops and the sound fades.

Respiratory rate

In seated position, the participant was provided a chair with backrest. The best time to count the respiratory rate is when a person is resting, perhaps after taking pulse rate of participant while fingers are still on the person's wrist. The participant's breathing might likely change if he or she knows it is being counted. The number of time the chest rises in one full minute was counted. This procedure was done pre and post exercise.

Data analysis

I. Descriptive statistics of mean, standard deviation and the range was used to describe participants demographic characteristics (Age, Weight and Height), selected cardiovascular parameters (Pulse rate, diastolic and systolic), and respiratory rate of participants.

II. Paired t-test was used to analyze differences in the response of the cardio respiratory parameters of hemiplegic stroke survivors' pre and post exercise.

III. Student t-test was used to compare means of cardiorespiratory parameters between male and female participants

Level of statistical significance was set at alpha = 0.05

Results

A total of 35 male and female ambulatory stroke survivors were employed for this study but there were three screen failures, due to some fluctuation in their cardiorespiratory parameter, therefore, 32 volunteer participants were recruited at the Department of Nursing, University of Shahid Beheshty for this study. The participants were volunteered hemiplegic stroke survivors who were certified as ambulatory stroke survivors and have had stroke for the period of at least three months and above, and had been regular on physiotherapy management. Seventeen participants (53.1%) were males, fifteen (46.9%) were females with a mean age of 52.37±10.15 years (range 33-74 years).

Socio-demographic characteristics of the participants

A Total of 32 volunteer participants were recruited at the Department of nursing, University of shahid beheshty for this study. The height, weight and body mass index of participants ranged between 1.40m-2.20m, 45kg-113kg 16.3-49.6 kg/m^2 respectively. The Mean and Standard deviation of the ages, weight, Heights and Body Mass Index (BMI) of the participants are shown on Table 1.Based on educational status, the highest participants were those with tertiary education (47.1%) while those who had no education (8.8%) were found to be with the least participants (Figure 1).

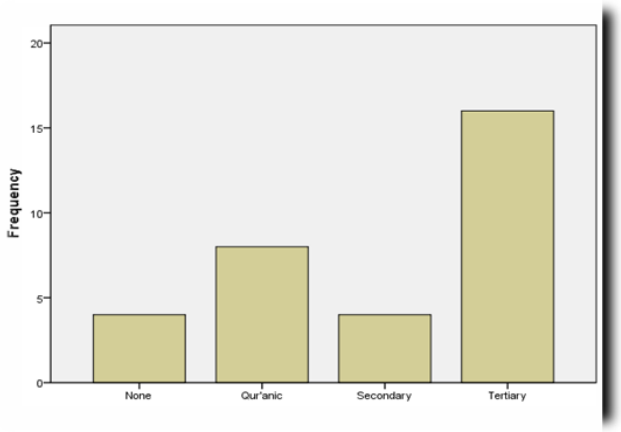

Figure 1 A Bar Chart showing educational status of participants.

Pulse rate response of participants after 15minutes Treadmill walking exercise

Table 2 shows the summary of the comparison of the mean pulse rate of the male and female participants following 15min treadmill walking exercises. Comparison with paired t-test shows significance difference for both male and female participants (male, p-value=0.006, t-value=3.19) and (female, p-value=0.02, t-value=2.59), while comparison on independent t-test between male and female groups was not significant (p-value=0.86, t-value=0.17).

Systolic blood pressure response of participants after 15minutes treadmill walking exercise

Table 3 shows the summary of the comparison of the mean resting systolic blood pressure of the participants and their responses following treadmill walking exercises after 15min. All the comparison for paired t-test shows significance difference for both male and female participants, (Male, p-value=0.003, t-value=2.67) and (female, p-value=0.01, t-value=1.07). Also comparison with independent t-test between male and female groups showed significant difference at baseline and after exercise (p-value=0.00, t-value=24.4).

Diastolic blood pressure response of participants after 15minutes treadmill exercise

Table 4 shows the summary of the comparison of the mean

resting diastolic blood pressure of the participants and their responses following the treadmill walking exercises after 15min.All the comparison for paired t-test shows no significance difference for both male and female participants, (male, p-value=0.44, t-value=0.79) and (female, p-value=0.85, t-value=0.18), while comparison between male and female group was significant at baseline and after the exercise (p-value=0.00, t-value=9.36).

Table 1 Demographic characteristics of the participants Total N=32

	Gender		
Variables	**Male n=17 X ±SD**	**Female n=15 X ±SD**	**X ±SD**
Age (yrs)	50.88±8.6	54.07±11.67	52.37±10.153
Weight (kg)	68.82±13.9,5	66.53±18.62	67.75±16.08
Height (m)	1.68±0.18	1.54±0.07	1.62±0.16
BMI (kg/m^2)	24.59±6.56	27.71±7.64	26.01±7.15

X, Mean; SD, standard deviation; BMI, body mass index

Table 2 Pulse rate response between gender and within gender after 15 minutes Treadmill walking exercises

	Gender			
Variables	**Male n=17 X ±SD**	**Female n=15 X ±SD**	**t**	**p value**
Initial PR (baseline)	76.47±11.48	75.73±12.95	0.17	0.86
PR After exercise		84.35±13.02	0.19	0.84
t	3.19	2.59		
P-value	0.006*	0.021*		

*Significance at 0.05 alpha; X, mean; SD, standard deviation; T-test, statistical test; PR, pulse rate

Table 3 Systolic blood pressure response between gender and within gender after treadmill walking exercise

	Gender			
Variables	**Male n=17 X ±SD**	**Female n=15 X ±SD**	**t**	**p value**
Initial SBP (baseline)	116.47±15.38	121.33±15.15	24.38	0.00*
SBP After exercise	122.94±15.72	126.00±16.38	25.9	0.00*
P-value	0.03*	0.01*		
t	2.67	1.07		

*Significance at 0.05 alpha; X, mean; SD, standard deviation; T-test, statistical test; SBP, systolic blood pressure

Table 4 Diastolic blood pressure response between gender and within gender after 15minutes treadmill exercise

	Gender			
Variables	**Male n=17 X ±SD**	**Female n=15 X ±SD**	**t**	**p value**
Initial DBP (baseline)	77.65±10.63	78.33±8.79	9.36	0
DBP After exercise	80.00±11.04	77.66±15.22	9.41	0
p-value	0.44	0.85		
t	0.79	0.18		

*Significance at 0.05 alpha; X, mean; SD, standard deviation; T-test, statistical test; DBP, diastolic blood pressure

Respiratory rate response of participants after 15minutes Treadmill walking exercise

Table 5 shows the comparison of the mean resting respiratory rate of the participants and their responses following treadmill walking exercises after 15min. All the comparison with paired t-test shows significance difference for both male and female participants (male, p-value=0.00, t-value=6.15) and (female, p-value=0.00, t-value=6.19). Comparison between male and female was significant at baseline and after exercise (p-value=0.00, t-value=14.5).

Table 5 Respiratory rate response between gender and within gender after 15minutes treadmill walking exercise

	Gender			
Variables	Male n=17 X ±SD	Female n=15 X ±SD	t	p value
Initial RR (baseline)	18.71 ± 1.79	19.00 ±1.51	14.5	0.00*
RR After exercise	21.59±2.00	21.73±2.28	15.12	
P-value	0.00*	0.00*		
t	6.15	6.19		

*Significance at 0.05 alpha; X, mean; SD, standard deviation; T-test, statistical test; RR, respiratory rate

Discussion

A total of thirty two (32) volunteer ambulatory hemiplegic stroke survivors age range 33-74 years were recruited at the Department of nursing University of shahid beheshty for this study. The participants were stroke survivors who have had stroke for the period of greater than three months; this finding is similar to the findings of Judith et al.[17] who recruited stroke survivors with post stroke duration of ≥3 months. The mean age of the participants was 52.37±10.15 years (range=33-74 years) in this study. This finding was not similar to the study of Jainane et al.[18] in which the mean age of the participants was 55.70±10.40 (range=50-72 years). The participants were regular on nursing management. Men have higher percentage of participants (53.1%) for this study than the female (47.9%), this is consistent with the study by Reeves et al., (2009) who reported men to be virtually 25% more than women in their study (male 71.6% and female 29.4%). The study was carried out at self-selected pace (speed) of the participants for 15mins.This is not similar with the findings by Jainane et al.[18] who reported a walking speed of >1.2m/s at baseline or when the inclusion criteria stated 'able to walk without help', it was however consistent to a study by Judith et al.[17] who reported participants' speed to be at self-selected pace in their study.

The result of this study shows that the pulse rate response of the participants was significant when compared to their mean pulse rate at rest before the exercise. This is in line with the study by Nishime et al.[19] who reported a significant difference in pulse rate of hemiplegic stroke survivors after early treadmill exercise irrespective of gender, the rise in pulse rate is due to a central withdrawal of parasympathetic arteriole during exercise. However, a comparison of the means of pulse rate between male and female participants indicated no significant difference; which was in line with the study by Zdenek et al.[20] who discovered no significant difference on comparison between genders. However, an article by Mackay-Lyons et al.[21] briefly mentioned gender difference in their data set but they had a smaller sample size and an unequal distribution of male (22) and females (7) in their study. They reported a significant difference with male participants having higher pulse rate values.

The comparison of the mean systolic blood pressure response of the participants after Treadmill walking exercise and the mean systolic blood pressure response of the participants at rest shows significant difference among male and female participants. This is consistent with the study by Kannel et al.[22] who reported an increase in systolic blood pressure which is statistically significant. The increase in systolic blood pressure during exercise increase the cardiac output brought about by increase in stroke volume and pulse rate, which exerts higher pressure on the blood vessels during the systolic phase of the cardiac circle. This was not in line to a study by Moreira et al.[22] which shows that blood pressure response was greater in their study with treadmill exercise but changes were not significant. Also, comparison of the means of systolic blood pressure between male and female participants indicated a significant difference with female participants having higher values, this is in agreement with a report by Kusuma et al.[23] who observed a significant difference in blood pressure response between gender, Another research by Gardner and Poehlman,[24] reported a positive and significant difference in blood pressure between male and female participants with male participants having higher values for blood pressure.

The result of this study also shows that the mean diastolic blood pressure response of the participants after Treadmill walking exercise and the mean diastolic blood pressure response of the participants at rest shows no significant difference for both male and female participants. This may be due to the variations in the speed of treadmill walking of the participants and the difference in the severity of stroke experienced by participants. However, it is possible to observe increase in diastolic blood pressure after treadmill exercise among stroke survivors due to the fact that stroke survivors are easily fatigued than healthy controls due to increase energy expenditure of the hemiplegic gait, age associated decline in fitness, their gross physical deconditioning and loss of muscle mass which strain their cardiovascular and metabolic capacity to produce ambulation.[25] Also, comparison of the means of diastolic blood pressure between male and female participants indicated a significant difference; which is in agreement with a report by Kusuma et al.[23] who observed a significant difference in blood pressure response between the male and female groups.

The comparison of the mean respiratory rate response of the participants after Treadmill walking exercise and the mean respiratory rate response of the participants at rest shows significant difference. This is in line to a study by Delket et al.[26] which shows that there is increase in respiratory rate post exercise, this increase might be related to the endurance capacity and enhanced strength of respiratory muscles of hemiplegic stroke survivors.[27] Also, comparison of the means of respiratory rate between male and female participants indicated a significant difference. this is due to the fact that, among females, the sinoatrial node in their heart recovers faster after each heart beat and prepares the heart to beat sooner than among men.[28] This is however not similar to a study by Meek et al., (2003) who reported that despite the difference in their physical parameters, there

appear to be no significant difference in respiratory rate between the two groups.

Conclusion

The outcome of this study shows that the cardiorespiratory response of ambulatory hemiplegic stroke survivors (male and female) post exercise was significant, therefore a significant increase of the ambulatory hemiplegic stroke survivors' cardiorespiratory parameters values at rest and following treadmill walking exercise for both the male and female participants can be observed for pulse rate and systolic blood pressure. However changes seen in diastolic blood pressure showed no significant difference (both male and female) for this study. Also, the systolic blood pressure, diastolic blood pressure and respiratory rate of male were significantly higher than that of the female participants but changes seen in the pulse rate between the male and female participants was not significant However comparison of pulse rate between male and female concluded that no gender appears to have higher response than the other which showed no significant difference. On the basis of this study, it appears that aerobic exercise intervention such as treadmill exercise is beneficial for improving cardiorespiratory fitness and should be incorporated into Stroke rehabilitation programme.[29]

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Conflict of interest

Author declares that there is no conflict of interest.

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