Original Research Article

Study of skeletal muscle fatigue with I-POD music and with intermittent rest using bicycle ergometry

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Abstract

Background: Exercise or physical activity is one of the basic needs of human body. Healthy living is associated with regular exercise which in turn is sometimes associated with strain and ill health. The measurement of the parameters like pulse rate, blood pressure and respiratory rate before, during and after exercise directly give assessment of the cardiovascular and respiratory functional changes. Music has positive effects on people and helps in better outcomes, increasing the endurance during, acts as mood modulator, regulates blood pressure, reduces the fatigue and encourages rhythmic movement during exercise. Our study tried to evaluate the effect of music on exercise performance in young untrained subjects. **Materials and Methods:** In this study, we tested the effect of music on sub maximal exercise performance time duration in young adults. 50 Males were subjected to standard physical exercise with and without music. Exercise endurance, Muscle fatigue, Pulse and respiratory rates were recorded during exercise with and without indian music. **Results:** Total exercise duration in whole group with music (16.53 ± 0.82675** min) was significantly greater than exercise duration without music (09.50 ± 0.57383 min). Also, we observed statistically significant higher values of Maximal heart rate with music than without music. There was significant correlation between endurance during exercise, respiratory rate, blood pressure and music. **Conclusion:** We can conclude that listening to Indian music through I-pod definitively enhances the performance, increases pulse and duration of exercise.

Key Words: Indian music, Exercise endurance, Muscle fatigue, Pulse and respiratory rate.

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Received Date: 12/08/2018 Revised Date: 03/09/2018 Accepted Date: 08/10/2018
DOI: https://doi.org/10.26611/103812

Access this article online	
Quick Response Code:	Website: www.medpulse.in
	Accessed Date: 14 October 2018

INTRODUCTION

Exercise or physical activity is one of the basic needs of human body[1-2]. Healthy living is associated with regular exercise which in turn is sometimes associated with strain and ill health. The amount of muscle mass at work, the intensity of the effort, its duration and the type of muscle contraction (isometric and isotonic) all influence the body response and adaptations to exercise[2-3]. The measurement of the parameters like pulse rate, blood pressure and respiratory rate before, during and after exercise directly give assessment of the cardiovascular and respiratory functional changes[3-5]. Bicycle ergometry may be employed as a quantitative tool for measuring accurately the increased workload independent of body weight[1-3]. The bicycle ergometric work is usually expressed in Kilo-poundmeters (KPM/min) or watts. O_2 uptake can be derived from watts with 1 W equal to 6 kpm/min[3-5]. Fatigue is a self protective mechanism against the damage of the contractile mechanism of muscle. Muscular fatigue during exercise is a common phenomenon, but its cause is still not clearly established although electrical and metabolic factors have been shown to be involved[5-7]. There are several techniques that allow for the analysis of muscle function and electrical activation and energy metabolism[2,3,8-10]. Literature is scant as regards the exact role of perceptual factors on a standard exercise bicycle and with i-pod music and with intermittent rest[1-2]. By alleviating the psychological stress, reducing the anxiety

How to cite this article: Rufus Rajkumar Peterson, Meher Kumar M. Study of skeletal muscle fatigue with I-POD music and with intermittent rest using bicycle ergometry. *MedPulse International Journal of Physiology.* October 2018; 8(1): 07-13. https://www.medpulse.in/Physiology/

and raising the threshold of perception of exertion, with music and intermittent rest, it is possible to favorably alter the cardiovascular dynamics and get the best work output from the subject and give a true estimate of the endurance[1-2,11-15]. Music has been shown to be an effective intervention to achieve a range of desirable psychological and performance effects among athletes[11-14]. The role of music in improving work output, particularly for repetitive work that does not require mental concentration is well recognized from industrial research[15-16]. The aim of this study was to determine the effects of listening to indian music using I-pod during progressive exercise. Hence the study on different factors which indirectly indicate endurance or fatigue while doing a fixed type of dynamic exercise like bicycle exercise is undertaken in younger age group of subjects. Also introduction of i-pod Indian music is done to the same subjects after rest and studied to find out how it modifies the effects of stress or fatigue. The results are compared and statistical analysis done.

MATERIALS AND METHODS

The present study is designed to analyze the effect of Indian music on skeletal muscle fatigue during the bicycle exercise in healthy human volunteers. The study was carried out in three modes: Mode A — Pre exercise mode (Base line). Mode B — Exercise test protocol without the addition of any perceptual factors. Mode C- Same test protocol as mode B, but manipulated by introducing subjective perceptual element by the way of presenting Indian music to the subject. 50 young male adult subjects between 18 to 22 years of age were recruited in the study. All the subjects were medical students who volunteered to participate in the study. Oral consent was taken from all the participants, and they were briefed the possible consequences during the study that. The subjects recruited for the study were not engaged in any form of regular physical exercise physical data of the participants like heights, weights were record and tabulated. This study was conducted in, Department of Physiology, Vishwabharathi Medical College, Kurnool and Rangaraya Medical College, Kakinada, Andhra Pradesh. The study was approved by the Institutional Ethics Committee (IEC/RMC/2008/67). Inclusion criteria followed before recruiting the subjects for the study: No history of chronic medical illness such as hypertension, diabetes mellitus, musculoskeletal illness, Traumatic injury etc. that could limit the subjects to perform exercise. All the subjects were informed regarding the study and tested for exercise in the morning hours over a period of 15 days. Per day we called 5 subjects and they were made to sit down and relax for 5-10 min before recording their resting heart rate using the pulse Oxy-meter. Then they were asked to peddle bicycle at self-selected speeds, and initial time was noted, the subjects were asked to stop the exercise if they felt fatigued or breathlessness. The pulse rates were monitored throughout the duration of exercise using a pulse Oxy-meter was placed on their index finger. The subjects were asked to perform the exercise in sets and every time their pulse rates were noted. Similar, exercise regimes were repeated with the same subjects with the music, recording of heart rate and duration of exercise was noted as previously. Total duration of the exercise was calculated by subtracting final and the initial timing. Recording of the pulse, respiratory rate, duration of exercise were noted in a similar fashion for all the 50 volunteers. Data about various parameters was noted and statistical analysis of data was performed using SPSS.

OBSERVATIONS AND RESULTS

The data of the study obtained at baseline before and after exercise with music were analysed. Their salient features are presented here.

Table 1: Age, Height and Weight of subjects participated in the study

	N	Minimum	Maximum	Mean	SD
AGE	30	18	22	20.23	1.357
Ht_cms	30	164	174	169.50	2.556
Wt_kgs	30	50	76	63.03	6.759

Table 1 represents the basic profile of study subjects i.e. Age, Height and Weight of subjects. Age varied from 18 to 22, had the mean of 20.23 and standard deviation of 1.357. Height varied from 164 to 174 cm, had a mean of 169.5 cm and standard deviation of 2.556. Weight varies from 50 to 76 kg, had a mean of 63.3 kg and a standard deviation of 6.759.

Table 2: Pulse, systolic-diastolic BP and respiratory rate before exercising

	N	Minimu	Maximu	Mean	Std.
Pulse _B	30	67	74	70.37	1.752
Sys_B	30	110	130	122.33	5.122
Dia_B	30	70	84	78.73	3.912
RR_B	30	16	18	16.73	0.785

Table 2 gives mean, standard deviation of the baseline measurements. The pulse varied from 67 to 74, had a mean of 70.37 with a standard deviation of 1,752. The Systolic BP varied from 110 to 130 mm Hg, had a mean of 122.33 and a standard deviation of 5.122. Diastolic BP varied from 70 to 84 mm Hg, had a mean of 78.73 and standard deviation of 3.912. The RR varied very little from 16 to 18, had a mean of 16.73 and standard deviation of 0.785.

Table 3: Pulse, systolic-diastolic BP, respiratory rate, energy spent, duration and distance covered after exercise without music.

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
PULSE_E	30	95	127	108.17	8.848
Sys_E	30	140	160	150.47	6.574
Dia_E	30	80	88	82.73	2.067
RR_E	30	24	30	27.27	1.818
ENERGY_E	30	68	74	70.60	1.453
DIST_E	30	6.10	6.22	6.1560	0.03654
DUR_E	30	8.3	11.3	9.495	0.8267

Table 3 gives mean, standard deviation of the parameters after exercise. Pulse had a mean ± standard deviation of 108.17 ± 8.848. Systolic BP had a mean ± standard deviation of 150.47 ± 6.572 mm Hg. Diastolic BP had a mean ± standard deviation of 82.73 ± 2.067 mm Hg. RR (Respiratory Rate) had a mean ± standard deviation of 27.27 ± 1.818. Energy expended had a mean ± standard deviation of 70.60 ± 1.453 calories. Distance covered had a mean ± standard deviation of 6.156 ± 0.036 km. The duration of exercise had a mean ± standard deviation of 9.495 ± 0.8267.

Table 4: Pulse, systolic-diastolic BP, respiratory rate, energy spent, duration and distance covered after exercise with music

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
PULSE_M	30	95	120	107.10	7.092
Sys_M	30	140	156	146.40	5.021
Dia_M	30	80	86	81.53	1.634
RR_M	30	29	32	30.57	1.073
ENERGY_M	30	125	130	127.37	1.520
DIST_M	30	11.02	11.30	11.0807	0.05558
DUR_M	30	15.30	17.35	16.5327	0.57383

Table 4 represents the mean, standard deviation of the parameters after exercise with music. The pulse had a mean ± standard deviation of 107.10 ± 7. Systolic BP had a mean ± standard deviation of 146.4 ± 5.021 mm Hg. Diastolic BP had a mean ± standard deviation of 81.53 ± 1.634. RR had a mean ± standard deviation of 30.57 ± 1.52 mm Hg. Energy expended had a mean ± standard deviation of 127.37 ± 1.52 calories.

Table 5: Comparison of parameters at baseline and parameters after exercise without music (Paired t test)

Paired Differences		Mean	Standard Deviation	Standard Error	t	df	P
Pair 1	Pulse_B - PUL	37.800	9.080	1.658	-	29	0.00
Pair 2	Sys_B - Sys	28.133	6.766	1.235	-	29	0.00
Pair 3	Dia_B - Dia	-4.000	3.751	0.685	-5.841	29	0.00
Pair 4	RR _B - RR	-10.533	1.889	0.345	-	29	0.00

Distance covered had a mean ± standard deviation of 11.0807 + 0.556 km. Duration of exercise had a mean + standard deviation of 16.5327 ± 0.57 ms. Comparison of the parameters at baseline and the parameters after exercise was done using paired t test and the results are presented in table 5. After exercise, the mean pulse rate showed an increase of 37.8 (± 9.08) compared to the baseline and this increase was statistically significant (t = 22.802, P = 0.0). After exercise, the mean systolic BP showed an increase of 28.133 (± 6.766) mm Hg compared to the baseline and this increase was statistically significant (t = 22.776, P = 0.0). After exercise, the diastolic BP showed an increase of 4.0 (±3.751) compared to the baseline and this increase was statistically significant (t = 5.841, P = 0.0). After exercise, the mean RR showed an increase of 10.533 (+1.889) compared to the baseline and this increase was statistically significant (t = 30.544, P = 0.0). In fact all parameters showed significant increase after exercise compared to baseline.

Table 6: Comparison of parameters at baseline and after exercise with Music (Paired t test)

Paired differences	Mean	SD	SEM	t	df	P
Pair 1 Pulse_B - PULSE M	-36.733	7.367	1.345	-27.311	29	.000
Pair 2 Sys_B - Sys_M	-24.067	7.017	1.281	-18.786	29	.000
Pair 3 Dia_B - Dia_M	-2.800	3.951	.721	-3.881	29	.001
Pair 4 RR _B - RR_M	-13.833	1.510	.276	-50.161	29	.000

Table 6 gives comparison of parameters at baseline and after exercise with Music with the results of Paired t test. After exercise with music, the mean pulse showed an increase of 36.733 (±7.367) compared to the baseline and this increase was statistically significant (t = 27.311, P = 0.0). After exercise with music the mean systolic BP showed an increase of 24.067 (±7.017) mm Hg compared to the baseline and this increase was statistically

significant (t = 18.786, P = 0.0). After exercise with music the mean diastolic BP showed an increase of 2.8 (±3.951) mm Hg compared to the baseline and this increase was statistically significant (t = 3.881, P = 0.001). After exercise with music the mean RR showed an increase of 13.833 (±1.51) compared to the baseline and this increase was statistically significant (t = 50.161, P = 0.0). All these parameters showed significant increase after exercise with music compared to baseline.

Table 7: Comparison of parameters after exercise and after exercise with Music (Paired t test)

Paired differences	Mean	Std. Deviation	Std. Error Mean	t	Df	P
Pair 1 PULSE _E - PULSE_M	1.067	9.184	1.677	0.636	29	0.530
Pair 2 Sys_E - Sys_M	4.067	7.381	1.348	3.018	29	0.005
Pair 3 Dia E - Dia M	1.200	1.864	.340	3.525	29	0.001
Pair 4 RR_E - RR_M	-3.300	1.896	.346	-9.531	29	0.000
Pair 5 ENERGY _E - ENERGY_M	-56.767	1.736	.317	-57.415	29	0.000
Pair 6 DIST_E - DIST_M	-4.925	0.06516	.01190	-413.928	29	0,000
Pair 7 DUR_E - DUR_M	-7.038	1.00225	.18299	-38.460	29	0.000

Table 7 gives comparison of parameters after exercise with parameters after exercise with Music along with results of tests of significance, paired t test. After exercise with music, the mean pulse showed a decrease of 1.067 (± 9.184) compared to the level after exercise without music and this decrease was not statistically significant (t = 0.636, P = 0.53). After exercise with music, the mean systolic BP showed a decrease of 4.067 (±7.381) mm Hg compared to the level after exercise without music and this decrease was statistically significant (t = 3.018, P = 0.005). After exercise with music, the mean diastolic BP showed a decrease of 1.2 (±1.864) mm Hg compared to the level after exercise without music and this decrease was statistically significant (t = 3.525, P = 0.001). After exercise with music, the mean RR showed an increase of 3.3 (±1.896) compared to the level after exercise without music and this increase was statistically significant (t = 9.531, P = 0.00). After exercise with music, the mean energy expended showed an increase of 56.767 (±1.736) calories compared to the level after exercise without music and this increase was statistically significant (t = 57.415, P = 0.00). After exercise with music, the mean distance covered showed an increase of 3.92 (±0.65) km compared to the level after exercise without music and this increase was statistically significant (t = 413.9, P = 0.00). After exercise with music, the mean duration showed an increase of 7.037 (±1.002) ms compared to the level after exercise without music and this increase was statistically significant (t = 38.46, P = 0.00). (df = degree of freedom, P = P-value,t = paired t test).

Table 8: Comparison of Means of each parameter at Baseline, before and after exercise with Music

		N	Mean	SD	Std. Error	Minimum	Maximum
Pulse	Baseline	30	70.3667	1.75152	0.31978	67.00	74.00
	After Exercise without music	30	108.17	8.84769	1.61536	95.00	127.00
	After Exercise with Music	30	107,10	7.09225	1.29486	95.00	120.00
Sys	Baseline	30	122.33	5.12151	0.93506	110.00	130.00
	After Exercise without music	30	150.47	6.57442	1.20032	140.00	160.00
	After Exercise with Music	30	146.40	5.02133	0.91677	140.00	156.00
Dia	Baseline	30	78.7333	3.91226	0.71428	70.00	84.00
	After Exercise without music	30	82.7333	2.06670	0.37733	80.00	88.00
	After Exercise with Music	30	81.5333	1.63440	0.29840	80.00	86.00
RR	Baseline	30	16.7333	0.78492	0.14331	16.00	18.00
	After Exercise without music	30	27.2667	1.81817	0.33195	24.00	30.00
	After Exercise with Music	30	30.5667	1.07265	0.19584	29.00	32.00
Energy	After Exercise without music	30	70.6000	1.45270	0.26523	68.00	74.00
	After Exercise with Music	30	127,37	1.51960	0.27744	125.00	130.00
Distance	After Exercise without music	30	6.1560	0.03654	0.00667	6.10	6.22
	After Exercise with Music	30	11.0807	0.05558	0.01015	11.02	11.30
Dur	After Exercise without music	30	9.4950	0.82675	.15094	8.30	11.30
	After Exercise with Music	30	16.5327	0.57383	.10477	15.30	17,35

In table 8 the means of each parameter at baseline, after exercise and after exercise with Music their standard deviation and their range (minimum and maximum) are given.

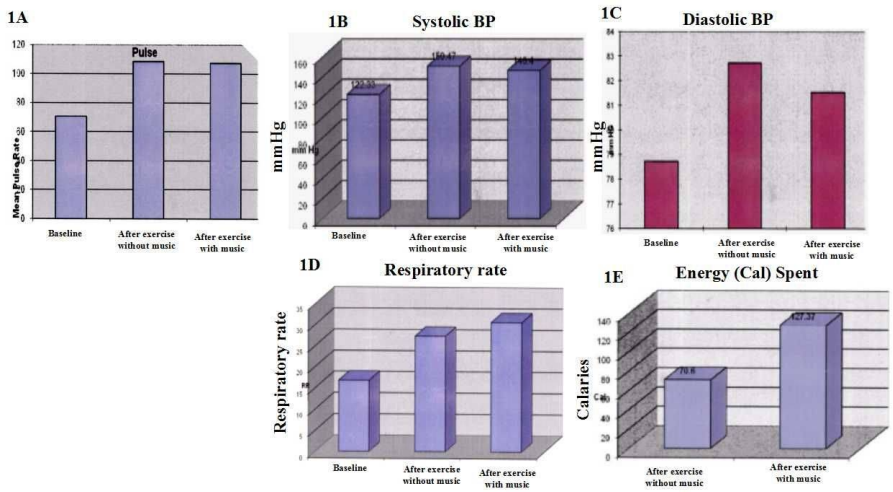

Figure 1: Pulse rate, blood pressure, respiratory rate and energy spent during exercise with and without music

The figure 1 offers a over view of the parameters performed during the exercise with and music. The observations clearly indicate the positive effects of Indian music in subjects helping them by regulation their blood pressure, pulse and respiratory rate and also helping them in increasing their endurance by reducing the fatigue during the exercise.

DISCUSSION

Although important studies have been made in the clinical application of Exercise Bicycle testing, little attention is paid to the perceptual aspects of exertion along with Indian music. The present study is intended to modify favorably the perceptual factors of exertion and examine their effects on the indicators of exercise time such as exercise duration, distance covered and other cardiovascular, respiratory functional variables. Borg (1980) made extensive studies on psychophysical basis of exertion opines that perceived exertion is the single best indicator of the degree of physical strain and constructed scales for rating perceived exertion known as "Borg's scale of perceived exertion"[3]. Against this back drop, the present work is designed to compare the endurance profiles of a homogenous group of subjects between a routine standard Pre-exercise Mode (Mode A), and with exercise without music (Mode —B) and finally with the introduction of Indian i-pod music during exercise (Mode —C). In our study, we observed significant rise in endurance, duration of exercise when Indian music was played through I-pod. Literature review, suggests listening to music certainly has significant effect on moderate exercises[14-16]. However, according to the report published by Pujol *et al* suggesting that there fast music did not show any effect on performance or fatigue in a maximum intensity cycling test lasting 30 sec [15], similar results were published by Elliott *et al*[7]. Numerous studies have reported that stimulative music enhances work output of self-paced aerobic exercise[16,17]. It is said that if proper music is not chosen during any workout, that could hinder the intensity of exercise and processing of other sensory cues[18-20]. It is suggested that high volume of music tends to dominate physiological cues and processing capacity, but in case of moderate volume both intensity of exercise and physiological cues can be monitored parallely. While the music may not alter the perception of fatigue when working out, but it can certainly change how one interprets or responds to sensation of high exertion[19-20]. In this present study, the standard deviation of age height and weight of the subjects varied from 18 to 22, had the mean of 20.23 and standard deviation of 1.357. Height varied from 164 ems to 174 ems had a mean of 169.5 ems and standard deviation of 2.556 weight varied from 50 kg to 76 kg., had a mean of 63.3 kg and a standard deviation of 6.759. The standard deviation of the baseline measurements are — the pulse varied from 67 to 74 had a mean of 70.37 with a standard deviation of 1.752. The systolic blood pressure varied from 110 to 130 mm of mercury, had a mean of 122.33 and a standard deviation of 5.122. Diastolic blood pressure varied from 70 to 84 mm of mercury, had a mean of 78.73 and a standard deviation of 3.912. The respiratory rate varied very little from 16 to 18, had a mean of 16.73 and a standard deviation of 0.785. The tables 3 describe the mean and standard deviation of the parameters pulse, systolic and diastolic blood pressure, respiratory rate, energy spent, distance covered and the duration of exercise - after exercise without music and the table 4 describe the above parameters after exercise with i-pod Indian music. Comparison of the parameters at baseline and the parameters after exercise without music was done using paired t-test and the results are presented in table 5. After

exercise, the mean pulse rate showed an increase 37.8 (+9.08) compared to the base line and this increase was statistically significant. (t=22.808, P= 0.0). After exercise, the mean systolic blood pressure showed an increase of 28.133 (+6.766) compared to the baseline and this increase was statistically significant (lt=22.776, P= 0.0). After exercise the diastolic blood pressure showed an increase of 4.0 (+ 3.751) compared to the base line and this increase was within the normal range but statistically significant. (t=5.841, P=0.0). After exercise the mean respiratory rate showed an increase 10.533 (+ 1.889) compared to the base line and this increase was statistically significant (t+ 30.544, P=0.0). In fact all the above parameters showed significant increase compared to the base line. And the comparison of the base line parameters to the parameters after exercise with i-pod Indian music was tabulated in the table no.6 - which showed a significant increase in all the parameters compared to the base line. The comparison of the parameters after exercise and after exercise with i-pod Indian music was tabulated in table no -7 and the results are significant. The mean pulse rate showed a decrease of 1.067 (+9.184) compared to the level after exercise without music and this decrease was not statistically significant (P=0.53). After exercise with Indian music, the mean systolic blood pressure showed a decrease of 4.067 (+7.381) mm mercury, compared to the level after exercise without Indian music and this decrease was statistically significant- (t=3.018, P= 0.005). After exercise with music, the mean diastolic blood pressure showed a decrease of 1.2 (+ 1.864) mm of mercury compared to the level after exercise without Indian music and this decrease was statistically significant, t= 3.525, P= 0.001), The diastolic BP is not raised to above normal level in any group wither B or C. After exercise with Indian music, the mean respiratory rate showed an increase of 3.3 (+ 1.896) compared to the level after exercise without i-pod Indian music and this increase was statistically significant (t= 9.531, P= 0.00). After exercise with Indian music, the mean energy expended showed an increase of 56.767 (+1.736) calories compared to the level after exercise without Indian music and this increase was statistically significant (t=57.415, P=0.00) After exercise with Indian music, the mean duration of exercise showed an increase of 7.037 (+1.002) ms compared to the level after exercise without Indian music and this increase was statistically significant. (t= 38.46, P=0.00). Also after exercise with the Indian music the mean distance covered showed an increase of 3.92 (± 0.65) km compared to the level after exercise without Indian music and this increase was statistically significant. (t= 413.9. P= 0, 00).

CONCLUSION

Our study was performed on 50 young adult subjects who were asked to exercise with and without music being played. Total duration of exercise and heart rate was observed to be more in the subjects, when they performed the exercise with music. Uniformity in exercise protocol and music played has shown correlation between increase in heart rate and the presence or absence of music. However, music may exert ergogenous effect and sometimes distractive in subjects under conditions of self-selected music and self-paced moderate exercise. Music played a role of a stress alleviator in young subjects and motivated them in extending their duration of exercise. Nevertheless, importance and beneficial effect of music on health cannot be underestimated.

1. Music increased the duration of exercise significantly in the subjects of 18-22 years of age.
2. Correlation was seen between increase in heart rate with duration of exercise and music.

However, further refinements by way of studying in larger number of subjects, and of diverse but comparable groups and with other parameters like blood lactate levels, gas exchange ratios etc., are essential to reinforce the results of this study.

ACKNOWLEDGMENT

I would like to extend my sincere thanks to Prof Dr Vijaykumar Peterson, Department of Plastic surgery; Dr Ramesh B, Associate Professor, Department of Biochemistry; Dr Rajesh, Associate Professor, Department of Anatomy, Vishwabharathi Medical College (Kurnool) for their guidance in preparation of the manuscript and also thank my HOD and colleagues for their support.

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