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Effect of step aerobic training for six weeks with 6 inches step platform at 118 and 126 beats per minute (BPM) on kinematic (Partial temporal) variables

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Abstract
A study conducted with the objective to test the effect of step aerobic training for six weeks with 6 inches step platform at 118 and 126 beats per minute (BPM) on selected kinematic (Partial Temporal) variables. The study was delimited to female subjects only (N=30), age ranging from 18 to 22 years and the intensity of training set to 118 and 126 beats per minute as protocol 1 and protocol 2 respectively. The study delimited to selected kinematic (Partial Temporal) variables namely as Leg Step up, Leg Step down, Upward Arm Swing, Downward Arm Swing and Ratio Variables. The Data Recording and quantification for pre test and post test were administered by Video Analysis (analysis for partial temporal variables) post test was conducted immediately after step aerobic training for 6 weeks with six inches step platform at 118 BMP as well as 126 BMP independently. Collected data was computed with mean, standard deviation and t-test. The selected variables for the study were Leg Step up Variable-Right (T1), Leg Step Up Variable-Left (T2), Leg Step Down Variable-Right (T3), Leg Step Down Variable-Left (T4), Upward Arm Swing Variable (T9), Downward Arm Swing Variable (T10), Ratio Variables (T17-T32). It was concluded that there was significant effect of step aerobic training on the selected kinematic (Partial Temporal) variables namely as T1,T2,T3, T4, T5, T6, T7, T8, T9, T10, T11, T12, T13,T14,T15,T16, T17, T18, T19, T20, T21, T22, T23, T24, T25, T26, T27, T28, T29, T30, T31 and T32 in both of the protocols. Effect of step aerobic training for six weeks in different protocol were found to be significant for biomechanical adaptation. All the selected kinematic (temporal) variables supported each other as per the existing literature or research and were found suitable for step aerobic training evaluation.

Keywords: step aerobic training, kinematic, temporal, BPM

Introduction

Aerobic training leads to aerobic fitness, also called cardio respiratory fitness, which is the ability of the heart and lungs to supply nutrients and oxygen to the muscles and other body tissues. In other words it enhances the ability to use oxygen in combination with fat and carbohydrate as fuel sources. Aerobic training exercises are the activities which increase the heart rate via the working of body muscles and strengthen the cardio respiratory system. An aerobically fit individual can work longer, more vigorously and achieve a quicker recovery. Frequency, duration, and intensity influence aerobic training. Frequency refers to how often an aerobic activity is performed, duration refers to the time spent at each session, and intensity refers to the percentage of maximum heart rate or heart rate reserve at work (C.B. Corbin, 1993).

A recent aerobic dance development is step aerobic training, which involves stepping up and down on a step platform to the rhythm of music and to the directions of an instructor. An understanding of step aerobic training is important in regard to its popularity, its advantages physiologically and biomechanically. Compared to other weight-bearing exercises, it accommodates varying fitness levels in a training session and can be challenging at any fitness level, from a beginner to a conditioned participant.

Research studies documented various factors that could affect the aerobic requirement (energy cost) of step aerobic training. These included body weight, step platform height, stepping rate, stepping pattern and use of hand-held weights. Further, Machado and Abrantes confirmed in their research that the increases in step intensity resulted in corresponding increases in ground reaction force(Machado, Abrantes).

The determination of biomechanical indicators during step aerobic training, was that the effect of increases in step platform height studied by Santos-Rocha, Veloso, Franco, & Correia, 2001, music tempo studied by Santos, Franco, Correira, Veloso, 2000 and increase in ground reaction force, investigated by Farrington and Dyson, 1995; Bezner *et al*., 1996; Maybury & Waterfield, 1997; Terriet and Finch, 1997, documented that increases in step platform height and music tempo appear to increase ground reaction force. According to these studies the height of a step platform reduces the time interval between the initial contact and the moment of achieving the maximum ground reaction force, which in turn leads to increases in mechanical work load and can therefore influence the way in which the type and technique of movement are adapted according to a study by Santos-Rocha *et al.*, 2001.

Objectives of the Study

The objectives of the study were to study the effect of step aerobic training with the protocol of lower step platform height (6 inches) and lower music tempo [118 beats per minute (BPM)] and higher music tempo [126 beats per minute(BPM)] with adaptation to the same independently on selected kinematic (temporal) variables.

Selection of the subjects

Adopting random sampling method, depending upon the willingness of the female subjects, 30 subjects were selected for the purpose of the study. The age of the subjects ranged from 18 years to 22 years. The objectives of the study and the procedure of the testing was explained to all the volunteers in advance before the experimentation was conducted. The consent form was obtained from all the participants in the study in advance.

Selection of the Variables

Details of Kinematic (Partial Temporal) Variables

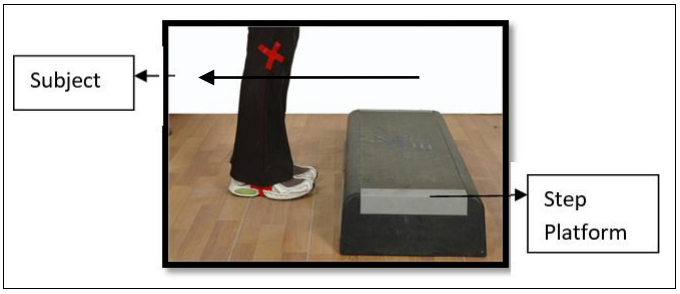

Fig 1: Kinematic Variable - Starting Position

Keeping in view the objectives of the study, following kinematic (partial temporal) categorized variables were selected:

Leg step up variables

Variable T1: Variable T1 refers to the time taken (milliseconds) to place the right foot (Basic Right, first foot up) on the step platform.

Variable T2: Variable T2 refers to the time taken (milliseconds) to place the left foot (Basic Right, second foot up) on the step platform from T1 position.

Variable T5: Variable T5 refers to the time taken (milliseconds) to place the left foot (Basic Left, first foot up) on the step platform.

Variable T6: Variable T6 refers to the time taken (milliseconds) to place the right foot (Basic Left, second foot up) on the step platform.

Leg step down variables

Variable T3: Variable T3 refers to the time taken (milliseconds) to place the right foot (Basic Right, first foot down) on the floor, while stepping down from T2 position.

Variable T4: Variable T4 refers to the time taken (milliseconds) to place the left foot (Basic Right, second foot down) on the floor, while stepping down from T3 position.

Variable T7: Variable T7 refers to the time taken (milliseconds) to place the left foot (Basic left, first foot down) on the floor, while stepping down from T6 position.

Variable T8: Variable T8 refers to the time taken (milliseconds) to place the right foot (Basic Right, second foot down) on the floor,while stepping down from T7 position.

Upward arm Swing Variables

Variable T9: Variable T9 refers to the time taken (milliseconds) to swing arms up in front of the body while performing variable T1.

Variable T11: Variable T11 refers to the time taken (milliseconds) to swing arms up in front of the body while performing variable T3.

Variable T13: Variable T13 refers to the time taken (milliseconds) to swing arms up in front of the body while performing variable T5.

Variable T15: Variable T15 refers to the time taken (milliseconds) to swing arms up in front of the body while performing variable T7.

Downward arm Swing Variables

Variable T10: Variable T10 refers to the time taken (milliseconds) to swing arms back to the starting position from variable T9, while performing variable T2.

Variable T12: Variable T12 refers to the time taken (milliseconds) to swing arms back to the starting position from variable T11, while performing variable T4.

Variable T14: Variable T14 refers to the time taken (milliseconds) to swing arms back to the starting position from variable T13, while performing variable T6.

Variable T16: Variable T10 refers to the time taken (milliseconds) to swing arms back to the starting position from variable T15, while performing variable T7.

Ratio Variables

Variable 17: Variable T17 refers to the ratio of variable T1 and variable T5. [Basic Right (first foot) and Basic Left (first foot) stepping up ratio].

Variable T18: Variable T18 refers to the ratio of variable T2 and variable T6. [Basic Right (second foot) and Basic Left (second foot) stepping up ratio].

Variable T19: Variable T19 refers to the ratio of variable T3 and variable T7. [Basic Right (first foot) and Basic Left (first foot) stepping down ratio].

Variable T20: Variable T20 refers to the ratio of variable T4 and variable T8. [Basic Right (second foot) and Basic Left (second foot) stepping down ratio].

Variable T21: Variable T21 refers to the ratio of variable T9 and variable T13. [Ratio of time taken to swing arms up while performing Basic Right (first foot up) and time taken to swing arms up while performing Basic Left (first foot up)].

Variable T22: Variable T22 refers to the ratio of variable T10 and variable T14. [Ratio of time taken to swing arms up while performing Basic Right (second foot up) and time taken to swing arms up while performing Basic Left (second foot up)].

Variable T23: Variable T23 refers to the ratio of variable T11 and variable T15. [Ratio of time taken to swing arms up while performing Basic Right (first foot down) and time taken to swing arms up while performing Basic Left (first foot down).

Variable T24: Variable T24 refers to the ratio of variable T12 and variable T16. [Ratio of time taken to swing arms up while

performing Basic Right (second foot down) and time taken to swing arms up while performing Basic Left (second foot down)].

Variable T25: Variable T25 refers to the ratio of variable T1 and variable T9. [Ratio of the time taken to place Basic Right (first foot up) on the step platform and the time taken to swing arms upward].

Variable T26: Variable T26 refers to the ratio of variable T2 and variable T10. [Ratio of the time taken to place Basic Right (second foot up) on the step platform and the time taken to swing arms downward].

Variable T27: Variable T27 refers to the ratio of variable T3 and variable T11. [Ratio of the time taken to place Basic Right (first foot down) on the floor and the time taken to swing arms up]

Variable T28: Variable T28 refers to the ratio of variable T4 and variable T12. [Ratio of the time taken to place Basic Right (second foot down) on the floor to the time taken and swing arms downward].

Variable T29: Variable T29 refers to the ratio of variable T5 and variable T13. [Ratio of the time taken to place Basic Left (first foot up) on the step platform and the time taken to swing arms upward].

Variable T30: Variable T30 refers to the ratio of variable T6 and variable T14. [Ratio of the time taken to place Basic Left (second foot up) on the step platform and the time taken to swing arms downward].

Variable T31: Variable T31 refers to the ratio of variable T7 and variable T15. [Ratio of the time taken to place Basic Left (first foot down) on the floor and the time taken to swing arms up].

Variable T32: Variable T32 refers to the ratio of variable T8 and variable T16. [Ratio of the time taken to place Basic Left (second foot down) on the floor and the time taken to swing arms downward].

Administration of the Tests and Collection of the Data

The video recording for the kinematic (partial temporal) variables were also conducted at the Judo hall of I.G.I.P.E.S.S., the Badminton hall of I.G.I.P.E.S.S., Fitness First and at Ozone Fitness Club. The Data Recording and quantification for protest and posttest were administered by Video Analysis (analysis for partial temporal variables). Post test was conducted immediately after step aerobics training for 6 weeks with six inches step platform at 118 BMP as well as 126 BMP independently.

Statistical Analysis

The data obtained was analyzed by computing the mean, standard deviation and two tail't' test by difference method was computed to these paired observations of protocol experiment for the selected kinematic variables. The research hypothesis was tested using the following formula:

$$t = \frac{\Sigma d}{\sqrt{\frac{N\Sigma d^2 - (\Sigma d)^2}{N}}}$$

where,

N = Sample Size

Σd = Sum Total of Difference between Pre Test and Post Test

Σd^2 = Sum Total of Square of Difference between Pre Test and Post Test

$(\Sigma d)^2$ = Whole Square of Sum of Difference between Pre Test and Post Test

The level of significance chosen was 0.05 for testing the hypothesis.

Table 1: Effect of Step aerobic Training for Six Weeks with 6 inch Step Platform at 118 Beats Per Minute (BPM) on Kinematic (Partial Temporal) Variables

S. No.	Variable	Test	Mean	SD	ΣD	ΣD2	(ΣD)2	T
1.	T1	Pre Test	0.14	0.01	0.22	0.01	0.05	3.12*
		Post Test	0.13	0.00				
2.	T2	Pre Test	0.15	0.00	0.14	0.00	0.02	5.12*
		Post Test	0.14	0.00				
3.	T3	Pre Test	0.16	0.01	0.14	0.00	0.02	5.12*
		Post Test	0.16	0.00				
4.	T4	Pre Test	0.12	0.00	0.26	0.00	0.07	7.68*
		Post Test	0.13	0.00				
5.	T5	Pre Test	0.14	0.00	0.28	0.01	0.08	4.05*
		Post Test	0.13	0.02				
6.	T6	Pre Test	0.15	0.00	0.15	0.00	0.02	4.87*
		Post Test	0.14	0.01				
7.	T7	Pre Test	0.17	0.06	0.30	0.01	0.09	4.16*
		Post Test	0.17	0.01				
8.	T8	Pre Test	0.13	0.04	0.23	0.00	0.05	5.52*
		Post Test	0.13	0.02				
9.	T9	Pre Test	0.00	0.00	4.02	0.54	16.16	132.54*
		Post Test	0.13	0.01				
10.	T10	Pre Test	0.00	0.00	4.23	0.60	17.89	195.12*
		Post Test	0.14	0.00				
11.	T11	Pre Test	0.00	0.00	4.60	0.71	21.16	178.16*
		Post Test	0.15	0.00				

12.	T12	Pre Test	0.00	0.00	4.02	0.54	16.16	132.54*
		Post Test	0.13	0.00				
13.	T13	Pre Test	0.00	0.00	4.03	0.55	16.24	57.36
		Post Test	0.14	0.00				
14.	T14	Pre Test	0.00	0.00	4.26	0.61	18.15	194.44*
		Post Test	0.14	0.02				
15.	T15	Pre Test	0.00	0.00	4.67	0.73	21.81	56.07*
		Post Test	0.16	0.03				
16.	*T16*	Pre Test	0.00	0.00	4.00	0.53	16.0	135.87*
		Post Test	0.13	0.02				
17.	T17	Pre Test	1.02	0.13	1.79	0.48	32.04	2.92*
		Post Test	0.97	0.06				
18.	T18	Pre Test	1.00	0.03	8.90	0.04	0.80	6.81*
		Post Test	1.00	0.04				
19.	T19	Pre Test	1.00	0.03	1.37	0.08	1.87	9.67*
		Post Test	1.00	0.05				
20.	T20	Pre Test	1.01	0.04	1.25	0.08	1.56	7.42*
		Post Test	0.99	0.05				
21.	T21	Pre Test	0.00	0.00	30.31	30.66	918.68	152.71*
		Post Test	1.01	0.07				
22.	T22	Pre Test	0.00	0.00	30.11	30.23	906.40	165.10*
		Post Test	1.00	0.05				
23.	T23	Pre Test	0.00	0.00	30.70	31.84	942.30	158.90*
		Post Test	1.01	0.06				
24.	T24	Pre Test	0.00	0.00	30.77	30.66	946.92	99.84*
		Post Test	1.00	0.07				
25.	T25	Pre Test	0.00	0.00	29.66	29.33	879.43	289.86*
		Post Test	0.98	0.03				
26.	T26	Pre Test	0.00	0.00	30.41	30.84	924.64	230.05*
		Post Test	1.01	0.02				
27.	T27	Pre Test	0.00	0.00	30.44	30.91	926.59	207.18*
		Post Test	1.01	0.03				
28.	T28	Pre Test	0.00	0.00	29.54	29.11	872.62	186.29*
		Post Test	0.98	0.04				
29.	T29	Pre Test	0.00	0.00	29.98	29.98	899.06	337.68*
		Post Test	0.99	0.02				
30.	T30	Pre Test	0.00	0.00	30.10	30.24	906.91	334.97*
		Post Test	0.99	0.04				
31.	T31	Pre Test	0.00	0.00	30.66	31.35	940.64	147.14*
		Post Test	1.01	0.06				
32.	T32	Pre Test	0.00	0.00	29.85	29.71	891.02	224.09*
		Post Test	0.98	0.04				

* Significant at 0.05 level
T1 – T16 = milliseconds
T17 - T32 = numeric
Notes: N = 30
Pretest =Test conducted before starting the experimental protocol.
Post Test= Test conducted after six weeks of training of the experimental protocol.
Protocol 1 = Performing ‘Basic Step' on 6 inch high step platform at 118 beats per min.

Table 2: Effect of Step aerobic Training for Six Weeks with 6 inches Step Platform at 126 Beats Per Minute (BPM) on Kinematic (Partial Temporal) Variables

S. No.	Variable	Test	Mean	SD	ΣD	ΣD2	(ΣD)2	t
1	T1	Pre Test	0.16	0.01	0.83	0.03	0.74	12.48*
		Post Test	0.13	0.00				
2	T2	Pre Test	0.16	0.01	0.53	0.01	0.28	10.98 *
		Post Test	0.14	0.00				
3	T3	Pre Test	0.17	0.02	0.66	0.02	0.44	9.45*
		Post Test	0.16	0.00				
4	T4	Pre Test	0.13	0.01	0.25	0.00	0.06	8.75*
		Post Test	0.12	0.01				
5	T5	Pre Test	0.16	0.03	0.84	0.04	0.71	5.93*
		Post Test	0.13	0.00				

6	T6	Pre Test	0.15	0.01	0.28	0.00	0.08	8.91*
		Post Test	0.14	0.00				
7	T7	Pre Test	0.18	0.02	0.76	0.03	0.58	6.35*
		Post Test	0.15	0.06				
8	T8	Pre Test	0.13	0.01	0.69	0.11	0.48	2.27*
		Post Test	0.13	0.00				
9	T9	Pre Test	0.00	0.00	3.80	0.48	14.44	129.08*
		Post Test	0.13	0.00				
10	T10	Pre Test	0.00	0.00	4.25	0.60	18.06	171.14*
		Post Test	0.14	0.00				
11	T11	Pre Test	0.00	0.00	4.65	0.72	21.62	150.87*
		Post Test	0.15	0.00				
12	T12	Pre Test	0.00	0.00	3.65	0.44	13.32	178.81*
		Post Test	0.12	0.00				
13	T13	Pre Test	0.00	0.00	3.95	0.52	15.60	113.24*
		Post Test	0.13	0.01				
14	T14	Pre Test	0.00	0.00	4.14	5918	171396	28.93*
		Post Test	0.14	0.00				
15	T15	Pre Test	0.00	0.00	4.28	0.61	18.32	152.60*
		Post Test	0.15	0.00				
16	T16	Pre Test	0.00	0.00	4.56	0.69	20.79	174.87*
		Post Test	0.13	0.06				
17	T17	Pre Test	1.01	0.06	4.05	0.65	16.80	12.60*
		Post Test	0.94	0.04				
18	T18	Pre Test	1.04	0.03	1.77	0.19	3.13	6.06*
		Post Test	0.99	0.04				
19	T19	Pre Test	1.01	0.04	1.69	0.14	2.87	8.13*
		Post Test	1.02	0.02				
20	T20	Pre Test	1.01	0.04	1.25	0.07	1.57	9.11*
		Post Test	1.00	0.04				
21	T21	Pre Test	0.00	0.00	1.49	0.11	2.22	7.41*
		Post Test	0.96	0.04				
22	T22	Pre Test	0.00	0.00	28.92	27.94	836.58	121.18*
		Post Test	0.99	0.04				
23	T23	Pre Test	0.00	0.00	29.75	29.55	884.96	128.62*
		Post Test	1.02	0.03				
24	T24	Pre Test	0.00	0.00	30.65	31.32	939.13	225.82*
		Post Test	1.00	0.04				
25	T25	Pre Test	0.00	0.00	29.98	30.01	898.95	142.34*
		Post Test	1.00	0.02				
26	T26	Pre Test	0.00	0.00	30.00	30.01	900.13	332.64*
		Post Test	1.00	0.01				
27	T27	Pre Test	0.00	0.00	30.00	30.30	899.98	428.90*
		Post Test	1.00	0.01				
28	T28	Pre Test	0.00	0.00	30.01	30.02	900.53	374.42*
		Post Test	1.00	0.01				
29	T29	Pre Test	0.00	0.00	29.94	29.89	896.59	457.70*
		Post Test	1.00	0.01				
30	T30	Pre Test	0.00	0.00	29.99	29.99	899.63	416.37*
		Post Test	1.00	0.01				
31	T31	Pre Test	0.00	0.00	30.01	30.03	900.73	395.46*
		Post Test	1.00	0.01				
32	T32	Pre Test	0.00	0.00	29.94	29.88	896.15	443.52*
		Post Test	1.00	0.01				

* Significant at 0.05 level
T1 – T16 = milliseconds
T17 - T32 = numeric
Notes: N = 30
Pre Test =Test conducted before starting the experimental protocol.
Post Test= Test conducted after six weeks of training of the experimental protocol.
Protocol 2 = Performing ‘Basic Step' on 6 inch high step platform at 126 beats per min.

Discussion of the Findings

A comparison between the pre test and post test scores of selected kinematic (partial temporal) variables projected that :-

1. There was decreasing trend was observed following the adaptation and no definite trend was observed following the increase of intensity of step aerobic training in regard to variable T1, T2, T5, T6, T7, T17, T18 and T20.
2. There was increasing trend was observed following the adaptation and no definite trend was observed following the increase of intensity of step aerobic training in regard to variable T9, T10, T11, T12, T13, T14, T15, T16, T19, T21, T22, T23, T24, T25, T26, T27, T28, T29, T30, T31 and T32.
3. There was no definite trend was observed following the adaptation and following the increase of intensity of step aerobic training in regard to the variable T3, T4 and T8.

Conclusions

1. There was significant effect of step aerobics training (Protocol 1 and Protocol 2) on the selected kinematic variables.
2. Six weeks of step aerobic training with two distinct protocols i.e. intensity of training, were found to be sufficient length of training (training cycle) for biomechanical adaptation.
3. It is finally concluded that the chronology of administration of step aerobic training should be as following

a. Lower step platform height (6 inches) and lower music tempo [118 beats per minute (BPM)].
b. Lower step platform height (6 inches) and higher music tempo [126 beats per minute (BPM)].

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