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Effect of step aerobic training for six weeks with 8 inches step platform at 118 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 8 inches step platform at 118 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 beats per minute as protocol. 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 8 inches step platform at 118 BMP. 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), Leg Step up Variable-Left (T5), Leg Step Up Variable-Right (T6), Leg Step Down Variable-Left (T7), Leg Step Down Variable-Right (T8),Upward Arm Swing while performing variable T1-Variable (T9), Downward Arm Swing Variable while performing variable T2 (T10), Upward Arm Swing while performing variable T3-Variable (T11), Downward Arm Swing Variable while performing variable T4 (T12), Upward Arm Swing while performing variable T5-Variable (T13), Downward Arm Swing Variable while performing variable T6 (T14), Upward Arm Swing while performing variable T7-Variable (T15), Downward Arm Swing Variable while performing variable T8 (T16), 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
Any form of vigorous activity inevitably produces forces that stretch, squeeze, bend, twist and vibrate the bones, muscles, joints, tendons and ligaments. Regular exposure to moderately high levels of force is actually desirable because mechanical stress produces structural changes that toughen important anatomical structures. For example, over a period of time, the forces exerted on the body during moderately vigorous exercise can increase the density of the bone so that it resists cracking and breaking. Exercise can also increase the tensile strength of tendons and ligaments so that they are less likely to be stretched or torn [1, 2].
Unfortunately, the forces exerted on the body during exercise can also have undesirable effects. When the forces exerted on the body during exercise become excessively large, there is an increased risk of discomfort and injury to muscles and bones and the various structures that hold them together. This is especially true if large forces are exerted repetitively over a period of time.

Objectives of the study
The objectives of the study were to study the effect of step aerobic training with the Protocol

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of 8 inches height step platform with music tempo of 118 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
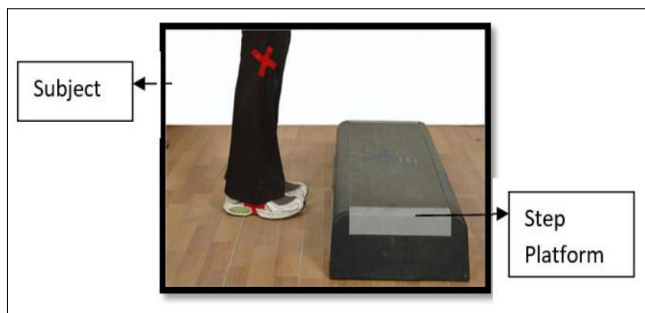### Details of kinematic (Partial temporal) variables

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 8 inches step platform at 118 BMP.

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:

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

Where,
N = Sample Size
Σd = Sum Total of Difference between Pre-test and Post-test
$\Sigma d2$ = 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 8 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	0.07	0.00	0.00	3.03*
		Post-test	0.14	0.01				
2.	T2	Pre-test	0.16	0.01	0.056	0.01	0.31	18.20*
		Post-test	0.14	0.00				
3.	T3	Pre-test	0.16	0.01	0.26	0.00	0.07	6.22*
		Post-test	0.16	0.00				
4.	T4	Pre-test	0.12	0.01	0.28	0.00	0.08	7.03*
		Post-test	0.12	0.00				
5.	T5	Pre-test	0.14	0.01	0.19	0.00	0.04	7.20*
		Post-test	0.13	0.01				
6.	T6	Pre-test	0.16	0.01	0.41	0.01	0.17	13.69*
		Post-test	0.14	0.01				
7.	T7	Pre-test	0.16	0.00	0.15	0.00	0.02	5.48*
		Post-test	0.16	0.00				
8.	T8	Pre-test	0.12	0.01	0.30	0.00	0.09	9.49*
		Post-test	0.13	0.01				
9.	T9	Pre-test	0.00	0.00	4.12	0.57	16.97	146.89*
		Post-test	0.14	0.00				
10.	T10	Pre-test	0.00	0.00	4.33	0.63	18.75	141.48*
		Post-test	0.13	0.00				
11.	T11	Pre-test	0.00	0.00	4.71	0.74	22.18	163.49*
		Post-test	0.16	0.00				
12.	T12	Pre-test	0.00	0.00	3.92	0.51	15.37	113.79*
		Post-test	0.13	0.01				
13.	T13	Pre-test	0.00	0.00	4.08	0.56	16.65	63.56*
		Post-test	0.13	0.01				
14.	T14	Pre-test	0.00	0.00	4.30	0.62	18.49	146.06*
		Post-test	0.14	0.00				
15.	T15	Pre-test	0.00	0.00	4.70	0.74	22.09	143.91*
		Post-test	0.16	0.00				
16.	T16	Pre-test	0.00	0.00	4.02	0.54	16.16	96.93*
		Post-test	0.13	0.01				
17.	T17	Pre-test	1.04	0.05	1.39	0.09	1.94	8.29*
		Post-test	1.01	0.03				
18.	T18	Pre-test	1.03	0.03	1.21	0.08	1.48	6.79*
		Post-test	0.99	0.03				

19.	T19	Pre-test	1.01	0.05	1.22	0.07	1.49	8.24*
		Post-test	1.01	0.03				
20.	T20	Pre-test	1.00	0.09	2.46	0.26	6.07	10.62*
		Post-test	0.99	0.02				
21.	T21	Pre-test	0.00	0.00	31.60	33.52	998.83	66.85*
		Post-test	1.05	0.06				
22.	T22	Pre-test	0.00	0.00	30.82	31.74	950.06	115.65*
		Post-test	1.03	0.09				
23.	T23	Pre-test	0.00	0.00	30.43	30.95	925.94	103.79*
		Post-test	1.01	0.05				
24.	T24	Pre-test	0.00	0.00	29.53	29.17	871.99	90.68*
		Post-test	0.98	0.06				
25.	T25	Pre-test	0.00	0.00	30.43	30.91	925.80	131.93*
		Post-test	1.01	0.04				
26.	T26	Pre-test	0.00	0.00	29.91	29.86	894.91	162.59*
		Post-test	1.00	0.03				
27.	T27	Pre-test	0.00	0.00	31.16	32.41	971.19	173.26*
		Post-test	1.04	0.03				
28.	T28	Pre-test	0.00	0.00	28.84	27.79	831.68	111.34*
		Post-test	0.96	0.05				
29.	T29	Pre-test	0.00	0.00	31.31	32.75	980.17	111.61*
		Post-test	1.04	0.05				
30.	T30	Pre-test	0.00	0.00	30.67	31.43	940.75	114.68*
		Post-test	1.02	0.05				
31.	T31	Pre-test	0.00	0.00	31.06	32.20	964.94	169.69*
		Post-test	1.04	0.03				
32.	T32	Pre-test	0.00	0.00	28.57	27.26	816.32	134.35*
		Post-test	0.95	0.04				

* 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 1 = Performing 'Basic Step' on 8 inch high step platform at 118 beats per min.

The analysis of data in Table 1 documented the Mean, Standard Deviation and 't' ratio on 32 variables. According to the table, the variable T1 has a mean and standard deviation of 0.14 ± 0.01 for pre-test and 0.14 ± 0.01 for post-test with significant 't' ratio (t=3.02) at .05 level. Variable T2 has a mean and standard deviation of 0.16 ± 0.01 for pre-test and 0.14 ± 0.00 for post-test with significant 't' ratio (t=18.20) at .05 level. The variable T3 has a mean and standard deviation of 0.16 ± 0.01 for pre-test and 0.16 ± 0.00 for post-test with significant 't' ratio (t=6.22) at .05 level. The variable T4 has a mean and standard deviation of 0.12 ± 0.01 for pre-test and 0.12 ± 0.00 for post-test with significant 't' ratio (t=7.03) at .05 level. The variable T5 has a mean and standard deviation of 0.14 ± 0.01 for pre-test and 0.13 ± 0.01 for post-test with significant 't' ratio (t =7.20) at .05 level. The variable T6 has a mean and standard deviation of 0.16 ± 0.01 for pre-test and 0.14 ± 0.01 for post-test with significant 't' ratio (t=13.69) at .05 level. The variable T7 has a mean and standard deviation of 0.16 ± 0.00 for pre-test and 0.16 ± 0.00 for post-test with significant 't' ratio (t=5.48) at .05 level. The variable T8 has a mean and standard deviation of 0.12 ± 0.01 for pre-test and 0.13 ± 0.01 for post-test with significant 't' ratio (t=9.49) at .05 level. The variable T9 has a mean and standard deviation of 0.00 ± 0.00 for pre-test and 0.14 ± 0.00 for post-test with significant 't' ratio (t=146.89) at .05 level. The variable T10 has a mean and standard deviation of 0.00 ± 0.00 for pre-test and 0.13 ± 0.00 for post-test with significant 't' ratio (t=141.48) at .05 level. The variable T11 has a mean and standard deviation of 0.00 ± 0.00 for pre-test and 0.16 ± 0.00 for post-test with significant 't' ratio (t=163.49) at .05 level. The variable T12 has a mean and standard deviation of 0.00 ± 0.00 for pre-test and 0.13 ± 0.01 for post-test with significant 't' ratio (t=113.79) at .05 level. The variable T13 has a mean and standard deviation of 0.00 ± 0.00 for pre-test and 0.13 ± 0.01 for post-test with significant 't' ratio (t=63.56) at .05 level. The variableT14 has a mean and standard deviation of 0.00 ± 0.00 for pre-test and 0.14 ± 0.00 for post-test with significant 't' ratio (t=146.06) at .05 level. The variable T15 has a mean and standard deviation of 0.00 ± 0.00 for pre-test and 0.16 ± 0.00 for post-test with significant 't' ratio (t=143.91) at .05 level. The variable T16 has a mean and standard deviation of 0.00 ± 0.00 for pre-test and 0.13 ± 0.01 for post-test with significant 't' ratio (t=96.93) at .05 level. The variable T17 has a mean and standard deviation of 1.04 ± 0.05 for pre-test and 1.01 ± 0.03 for post-test with significant 't' ratio (t=8.29) at .05 level. The variable T18 has a mean and standard deviation 1.03 ± 0.03 for pre-test and 0.99 ± 0.03 for post-test with significant 't' ratio (t=6.79) at .05 level. The variable T19 has a mean and standard deviation of 1.01 ± 0.05 for pre-test and 1.01 ± 0.03 for post-test with significant 't' ratio (t=8.24) at .05 level. The variable T20 has a mean and standard deviation of 1.0 ± 0.09 for pre-test and 0.99 ± 0.02 for post-test with significant 't' ratio (t=10.62) at .05 level. The variable T21 has a mean and standard deviation of 0.00 ± 0.00 for pre-test and 1.05 ± 0.06 for post-test with significant 't' ratio (t=66.85) at .05 level. The variable T22 has a mean and standard deviation of 0.00 ± 0.00 for pre-test and 1.03 ± 0.09 for post-test with significant 't' ratio (t=115.65)at .05 level. The variable T23 has a mean and standard deviation of 0.00 ± 0.00 for pre-test and 1.01 ± 0.05 for post-test with significant 't' ratio (t=103.79)at .05 level. The variable T24 has a mean and standard deviation of 0.00 ± 0.00 for pre-test and 0.98 ± 0.06 for post-test with significant 't' ratio (t=90.68) at .05 level. The variable T25 has a mean and standard deviation of 0.00 ± 0.00 for pre-test and 1.01 ± 0.04 for post-test with significant 't' ratio (t=131.93).05 level. The variable T26 has a mean and standard deviation of 0.00 ± 0.00 for pre-test and 1.00 ± 0.03

for post-test with significant 't' ratio (t=162.59) at .05 level. The variable T27 has a mean and standard deviation of 0.00 ± 0.00 for pre-test and 1.04 ± 0.03 for post-test with significant 't' ratio (t=173.26) at .05 level. The variable T28 has a mean and standard deviation of 0.00 ± 0.00 for pre-test and 0.96 ± 0.05 for post-test with significant 't' ratio (t=111.34) at .05 level. The variable T29 has a mean and standard deviation of 0.00 ± 0.00 for pre-test and 1.04 ± 0.05 for post-test with significant 't' ratio (t=111.61). The variable T30 has a mean and standard deviation of 0.00 ± 0.00 for pre-test and 1.02 ± 0.05 for post-test with significant 't' ratio (t=114.68) at .05 level. The variable T31 has a mean and standard deviation of 0.00 ± 0.00 for pre-test and 1.04 ± 0.03 for post-test with significant 't' ratio (t=169.69) at .05 level. The variable T32 has a mean and standard deviation of 0.00 ± 0.00 for pre-test and 0.95 ± 0.04 for post-test with significant 't' ratio (t=134.35).

Discussion of the findings

A comparison between the pre-test and post-test scores of selected kinematic (partial temporal) variables projected that: There was decreasing trend was observed following the adaptation for all variables.

Conclusions

1. There was significant effect of step aerobics training on the selected kinematic variables.
2. Six weeks of step aerobic training were found to be sufficient length of training (training cycle) for biomechanical adaptation.

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