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Effect of six weeks step aerobic training on selected kinetic (Ground reaction force) and kinematic (Temporal) variables of female with a step height of 8 inches and intensity of 118 beats per minute

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Abstract
A study conducted with the objective to test the effect of six weeks step aerobic training on selected kinetic (Ground Reaction Force) and Kinematic (Temporal) variables of female. The study was delimited to female subjects only (N=16), age ranging from 18 to 22 years, height of step platform set to 8 inches and intensity of training set to 118 beats per minute. The study delimited to selected kinetic (ground reaction force) variables namely as Peak Force in X-axis on Force Plate 2(PF2X), Peak Force in y-axis on Force Plate 2 (PF2Y), Peak Force in z-axis on Force Plate 2 (PF2Z), Peak Force in X-axis on Force plate 1(PF1X), Peak Force in Y-axis on Force Plate 1(PF1Y), Peak Force in Z-axis on Force Plate 1(PF1Z), Kinematic (Temporal Variables) namely as Time taken to achieve Peak Force in X-axis on Force Plate 2(TPF2X), Time taken to achieve Peak Force in Y-axis on Force Plate 2(TPF2Y), Time taken to achieve Peak Force in Z-axis on Force Plate 2(TPF2Z), Time taken to achieve Peak Force in X-axis on Force plate 1(TPF1X), Time taken to achieve Peak Force i in Y-axis on force plate 1(TPF1Y), Time taken to achieve peak force in Z- axis on force plate 1(TPF1Z). The Data Recording and quantification for pre test and post test were administered by Dynamometric Analysis (force plate recordings) was performed. Collected data were computed with mean, standard deviation and t-test. The variables namely as PF1Y, PF2Y, PF2Z, TPF2X, TPF2Y, TPF2Z and TPF1Y has significantly increased and variables TPF1X, PF1X, PF1Z, PF2X, TPF1Z decreased significantly. Six weeks of step aerobic training were found to be sufficient length of training (training cycle) for biomechanical adaptation. All the selected kinetic (ground reaction force) and 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, ground reaction force

Introduction
Aerobics training aims to increase the consumption of the quantity of oxygen consumed whereas step aerobic training tries to build towards achieving the same goals through more intensive workouts. To do so, it requires the use of a step platform that provides a challenge through the integration of an action consisting of stepping onto a step platform, resulting in a more intensive form of workout. Another great advantage that is reaped from step aerobic training is that it is a low-impact activity and hence its impact forces are lower compared to that of other activities such as running or jogging. Aerobic exercise is an important part of a well-rounded exercise routine. Many different forms of exercise can give you an effective cardiovascular workout, and step aerobics is one of them. Step aerobics was introduced in the 1980s as part of the aerobics craze, and is still utilized in gyms and health clubs for a complete body workout. A step aerobics session typically consists of sets of choreographed movements performed on a raised platform. The movements are usually accompanied by music and are designed to work the lower body, upper body and cardiovascular system. (Mccarron, 2017).

There are different protocol of training and testing of step aerobic but not biomechanically validated about the biomechanical adaptation. The question to be answered that whether a minimum height of step with minimum possible intensity (i.e. 118 beats per minute) for six weeks, 5 days per week with a duration of 30 minutes can lead to biomechanical adaptation i.e. Ground Reaction Force (GRF) parameters.

Methodology
16 female subjects were selected for the purpose of the study. The age of the subjects ranged from 18 years to 22 years. Training for 30 min. (which included 5 min. for warm up and cool down), 5 times a week for 6 weeks, height of step platform set to 8 inches and intensity of training set to 118 beats per minute. The nature of the study and the procedure of the testing was explained to all the volunteers in advance before the experimentation was conducted. The following Kinetic (Ground Reaction Force) Variables were selected for the study:- PF2X = Peak Force in X-axis on Force Plate 2 mounted on logs of wood PF2Y = Peak Force in y-axis on Force Plate 2 mounted on logs of wood. PF2Z = Peak Force in z-axis on Force Plate 2 mounted on logs of wood. PF1X = Peak Force in X-axis on Force plate 1 mounted on the floor adjacent to the step platform. PF1Y = Peak Force in Y-axis on Force Plate 1 mounted on the floor adjacent to the step platform. PF1Z = Peak Force in Z-axis on Force Plate 1

mounted on the floor adjacent to the step platform. TPF2X = Time taken to achieve Peak Force in X-axis on Force Plate 2 mounted on logs of wood. TPF2Y = Time taken to achieve Peak Force in Y-axis on Force Plate 2 mounted on logs of wood. TPF2Z = Time taken to achieve Peak Force in Z-axis on Force Plate 2 mounted on logs of wood. TPF1X= Time taken to achieve Peak Force in X-axis on Force plate 1 mounted on the floor adjacent to the step platform. TPF1Y = Time taken to achieve Peak Force i in Y-axis on Force Plate 1 mounted on the floor adjacent to the step platform. TPF1Z = Time taken to achieve Peak Force in Z-axis on Force Plate 1 mounted on the floor adjacent to the step platform.

The study was conducted by adopting test-retest design. According to the design of the study, all the subjects were tested (pre test) before step aerobic training. Thereafter, step aerobic training was given for a period of six weeks to the selected subjects as per the protocol. After six weeks of training the subjects were retested (post test). The recording was taken at Human Ergonomics Laboratory, DIPAS, Delhi. Each recording duration was 10 seconds for each subject.

Note: The post test was conducted for subjects who had completed their respective training protocols for a minimum of five days a week for a period of six weeks.

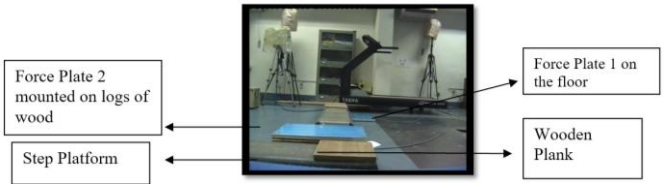

Fig 1: Aerobic Training Set Up

Table 1: List of Abbrevations

Abbrevations	Name of Variables
PF2X	Peak Force in X-axis on Force Plate 2 mounted on logs of wood at 8" height
PF2Y	Peak Force in y-axis on Force Plate 2 mounted on logs of wood at 8" height
PF2Z	Peak Force in z-axis on Force Plate 2 mounted on logs of wood at 8" height
PF1X	Peak Force in X-axis on Force plate 1 mounted on the floor adjacent to the step platform
PF1Y	Peak Force in Y-axis on Force Plate 1 mounted on the floor adjacent to the step platform
PF1Z	Peak Force in Z-axis on Force Plate 1 mounted on the floor adjacent to the step platform
TPF2X	Time taken to achieve Peak Force in X-axis on Force Plate 2 mounted on logs of wood
TPF2Y	Time taken to achieve Peak Force in Y-axis on Force Plate 2 mounted on logs of wood
TPF2Z	Time taken to achieve Peak Force in Z-axis on Force Plate 2 mounted on logs of wood
TPF1X	Time taken to achieve Peak Force in X-axis on Force plate 1 mounted on the floor adjacent to the step platform.
TPF1Y	Time taken to achieve Peak Force i in Y-axis on Force Plate 1 mounted on the floor adjacent to the step platform.
TPF1Z	Time taken to achieve Peak Force in Z-axis on Force Plate 1 mounted on the floor adjacent to the step platform
Pre Test	Test conducted before starting the experimental treatment
Post Test	Test conducted after six weeks of step aerobic training.

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 kinetic (ground reaction force) 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 2: Effect of Step Aerobic Training for Six Weeks with 6 inch Step Platform at 126 Beats Per Minute (BPM) on Kinetic (Ground Reaction Force) and Kinematic (Temporal) Variables

S. No	VARIABLE	TEST	MEAN	SD	ΣD	ΣD^2	$(\Sigma D)^2$	t
1.	PF2X	Pre Test	40.55	17.84	846.46	32851.46	716499.69	8.28*
		Post Test	36.70	17.90				
2.	PF2Y	Pre Test	49.69	15.52	2600.30	267796.09	6761536.08	10.94*
		Post Test	84.41	15.91				
3.	PF2Z	Pre Test	546.24	55.46	1441.37	99216.86	2077534.11	7.78*
		Post Test	587.71	65.51				
4.	PF1X	Pre Test	71.39	19.63	811.42	62928.10	658402.99	3.94*
		Post Test	47.92	14.80				
5.	PF1Y	Pre Test	61.28	13.99	2991.18	428757.37	8947151.23	7.74*
		Post Test	83.52	13.83				
6.	PF1Z	Pre Test	841.43	92.06	2609.06	346659.32	4992.92	4.43*
		Post Test	795.22	80.00				

7.	TPF2X	Pre Test	1.22	0.81	50.25	104.89	2525.06	9.86*
		Post Test	2.75	0.68				
8.	TPF2Y	Pre Test	1.13	0.79	59.51	133.71	3541.44	12.40*
		Post Test	2.99	0.89				
9.	TPF2Z	Pre Test	1.10	0.76	42.32	81.36	1790.98	8.40*
		Post Test	2.43	0.85				
10.	TPF1X	Pre Test	6.83	1.06	52.94	112.28	2802.11	10.65*
		Post Test	5.49	0.91				
11.	TPF1Y	Pre Test	5.63	0.83	52.68	114.60	2774.66	9.97*
		Post Test	7.24	0.92				
12.	TPF1Z	Pre Test	7.14	1.55	52.50	107.76	2756.25	11.29*
		Post Test	5.94	1.00				

Note: *Significant at 0.05 level, N = 32, Time = ms, Force= N

The analysis of data in Table-2 documented the mean, standard deviation and 't' ratio of kinetic (ground reaction force) variables PF1X, PF1Y, PF1Z, PF2X, PF2Y, PF2Z, TPF1X,TPF1Y, TPF1Z, TPF2X, TPF2Y and TPF2Z recorded at pre test and post test of Protocol 3. According to the table the mean and standard deviation of PF2X pre test was 40.55± 17.84 and post test was 36.70± 17.90, with significant 't' ratio (t= 8.28) at.05 level. Mean and standard deviation of PF2Y pre test was 49.69± 15.52 post test was 84.41 ± 15.91 with significant 't' ratio (t= 10.94) at.05 level. Mean and standard deviation of PF2Z pre test was 546.24 ± 55.46 post test was 587.71± 65.51 with significant 't' ratio (t= 7.78) at.05 level. Mean and standard deviation of PF1X pre test was 71.39 ± 19.63 and post test was 47.92± 14.80 with significant 't' ratio (t= 3.94) at.05 level. Mean and standard deviation of PF1Y pre test was 61.28 ± 13.99 and post test was 83.52 ± 13.83 with significant 't' ratio (t= 7.74) at.05 level. Mean and standard deviation of PF1Z pre test was 841.43 ± 92.06 and post test was 795.22± 80.00 with significant 't' ratio (t= 4.43) at.05 level. Mean and standard deviation of TPF2X pre test was 1.22 ± 0.81 and post test was 2.7 ± 0.68 with significant 't' ratio (t= 9.86) at.05 level. Mean and standard deviation of TPF2Y pre test was 1.13± 0.79 and post test was 2.99 ± 0.89 with significant 't' ratio (t= 12.40) at.05 level. Mean and standard deviation of TPF2Z pre test was 1.10± 0.76 and Post Test was 2.43± 0.85 with significant 't' ratio (t= 8.40) at.05 level. Mean and standard deviation of TPF1X pre test was 6.83 ± 1.06 and post test was 5.49 ± 0.91 with significant 't' ratio (t= 10.65) at.05 level. Mean and standard deviation of TPF1Y pre test was 5.63 ± 0.83 and post test was 7.24± 0.92 with significant 't' ratio (t= 9.97) at.05 level. Mean and standard deviation of TPF1Z pre test was 7.14± 1.55 post test was 5.94± 1.00 with significant 't' ratio (t= 11.29) at.05 level.

Discussion of Findings

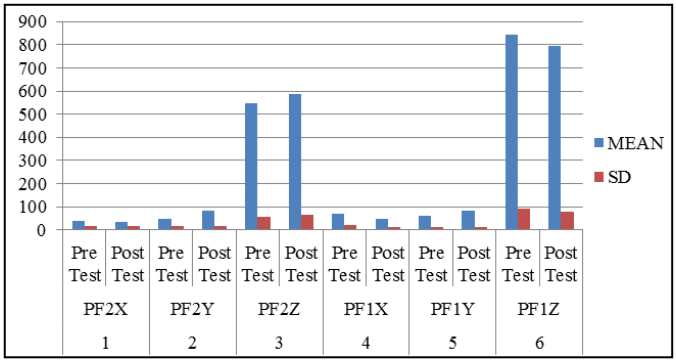

Fig 2: Training Effects on GRF (Ground Reaction Force) Variables

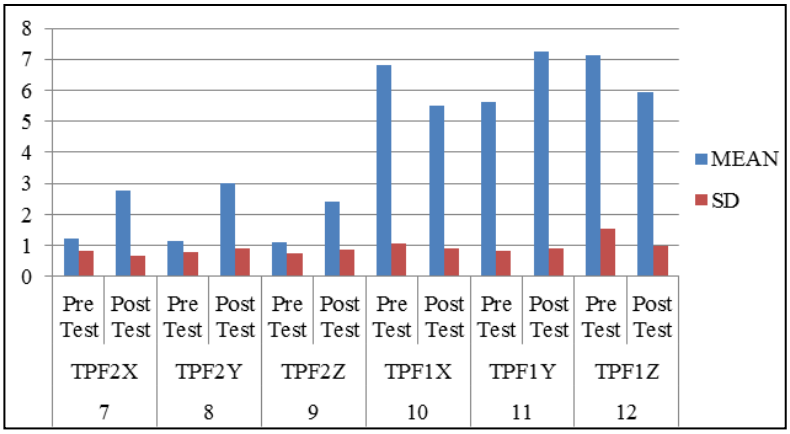

Fig 3: Training Effects on Temporal Characteristics on Ground Reaction Force (GRF)

Conclusions

It was concluded that there was significant effect of step aerobic training on the selected kinetic and kinematic variables which are given below:

1. Peak Force in X-axis on Force plate 1 mounted on the floor adjacent to the step platform (PF1X) was significantly decreased.
2. Peak Force in Y-axis on Force Plate 1 mounted on the floor adjacent to the step platform (PF1Y) was significantly increased.

3. Peak Force in Z-axis on Force Plate 1 mounted on the floor adjacent to the step platform (PF1Z) was significantly decreased.
4. Peak Force in X-axis on Force Plate 2 mounted on logs of wood at 8" height (PF2X) was significantly decreased.
5. Peak Force in y-axis on Force Plate 2 mounted on logs of wood at 8" height (PF2Y) was significantly increased.
6. Peak Force in z-axis on Force Plate 2 mounted on logs of wood at 8" height (PF2Z) was significantly increased.
7. Time taken to achieve Peak Force in X-axis on Force plate 1 mounted on the floor adjacent to the step platform (TPF1X) was significantly decreased.
8. Time taken to achieve Peak Force i in Y-axis on Force Plate 1 mounted on the floor adjacent to the step platform (TPF1Y) was significantly increased.
9. Time taken to achieve Peak Force in Z-axis on Force Plate 1 mounted on the floor adjacent to the step platform (TPF1Z) was significantly decreased.
10. Time taken to achieve Peak Force in X-axis on Force Plate 2 mounted on logs of wood (TPF2X) was significantly increased.
11. Time taken to achieve Peak Force in Y-axis on Force Plate 2 mounted on logs of wood (TPF2Y) was significantly increased.
12. Time taken to achieve Peak Force in Z-axis on Force Plate 2 mounted on logs of wood (TPF2Z) was significantly increased.

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References
1. Shalini SS. A Study on the Effect of Step Aerobic Training on Selected Ground Reaction Force Variables of Female:A thesis in Physical Education (Doctoral, s Thesis). University of Delhi, Delhi, India, 2010.
2. Shephard RJ, Fitness of a Nation: Lessons from the Canada Fitness Survey. Basel: S Karger, 1986.
3. Smith SF, Smith CM. Personal Health Choices. Boston: Jones and Barlett Publishers, inc, 1990.
4. Wilmore JH, Design Issues and Alternatives in Assessing Physical Fitness among Apparently Healthy Adults in a Health Examination Survey of the General Population". In: Assessing Physical Fitness and Activity in General Population Studies, T. F. Drury (Ed.). Washington, DC: U.S. Public Health Service, National Center for Health Statistics. 1988, 107-140.
5. Bacon C, Myers T, Karageorghis CI. Effect of Movement-Music Synchrony and Tempo on Exercise Oxygen Consumption. Manuscript Submitted for Publication, 2008.
6. Francis P, Carley J, Kolen P. The Effect of Platform Height on Knee Joint Kinematics and Vertical Ground Reaction Forces in Step Training. San Diego University Biomechanics Laboratory. Awaiting Publication, 2008.
7. Haskell WL, Montoye HJ, Orenstein D. Physical Activity and Exercise to Achieve Health Related Physical Fitness Components. Public Health Reports. 1987; 100:202-21.
8. Newton SJ, Zebas CJ, Schroeder JM, Crussemeyer JA. Rear foot Motion of the Basic Step and Backward Lunge at Different Step Heights. American College of Sports Medicine. National Convention. San Francisco, CA, 2003.