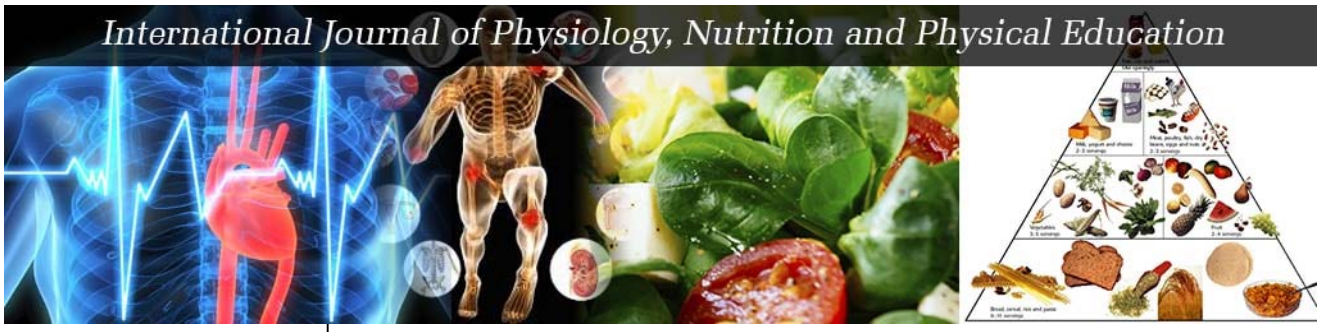

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Effect of six weeks step aerobic training on selected kinetic (Ground Reaction Force) and kinematic (Temporal) variables of female with step height of 6 inches and intensity of 118 beats per minute

Dr. Sonia Shalini, Raghvendra Shukla and Dr. Dhananjoy Shaw

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 6 inches and intensity of training set to 118 beats per minute. The study delimited to selected kinetic (ground reaction force) and kinematic(Temporal) 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), 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, TPF1X, TPF2X, TPF2Y, TPF2Z has significantly increased and PF1X, PF1Z, PF2X, TPF1Y, 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) 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
Ground reaction force (GRF) has a positive effect on bone mineral which in turn increases bone strength. The researchers also state that bone tissue responds to dynamic rather than static loading, the magnitude of the external load, the rate at which load is introduced, and the duration of the loading bout. These studies recommended short bouts 2 to 5 days per week of minimum load of three times the body weight. Further engaging in exercise during skeletal growth is unequivocally more osteogenic than during skeletal maturity. (Shalini, 2010) [1].

The popularity of step aerobic training is ever increasing which can be sensed from a number of step videos on the internet like the steptube.com and various others sites dedicated only to step aerobic training. Step aerobic training is also seen as a number one activity in various fitness and health clubs in our country. The reason is that step aerobic training is an intense and challenging fitness programme which increases bone density and the capacity of resistance of tendon and ligament tension. At the same time, it does not result in joint stressing as other activities do like running and jogging. However, since step aerobic training is a repetitive action, injuries can occur such as overuse injuries, foot injuries, knee injuries due to improper teaching, execution and choreography etc (Shalini, 2010) [1].

The question to be answered that whether a minimum 6 inches 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 6 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.

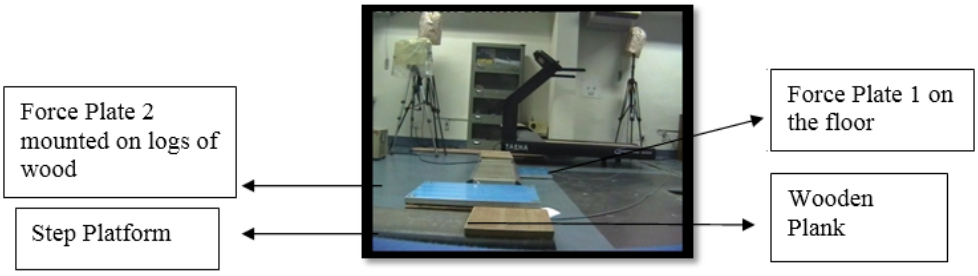

Fig 1: Aerobic Training Set Up

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 6" height
PF2Y	Peak Force in y-axis on Force Plate 2 mounted on logs of wood at 6" height
PF2Z	Peak Force in z-axis on Force Plate 2 mounted on logs of wood at 6" 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 118 Beats Per Minute (BPM) on Kinetic (Ground Reaction Force) Variables

S. No.	Variable	Test	Mean	SD	ΣD	ΣD^2	$(\Sigma D)^2$	t
1.	PF2X	Pre Test	29.27	13.04	601.02	15997.75	361224.93	8.76*
		Post Test	23.58	12.07				
2.	PF2Y	Pre Test	44.63	28.27	1200.15	108120.68	1440356.54	4.78*
		Post Test	77.35	29.52				
3.	PF2Z	Pre Test	331.79	112.25	3293.06	513943.41	10844221.32	7.87*
		Post Test	333.99	66.75				
4.	PF1X	Pre Test	49.77	29.51	1469.45	108289.69	2159295.58	7.27*
		Post Test	35.16	25.58				
5.	PF1Y	Pre Test	45.72	25.12	1762.57	168499.05	3106638.92	6.60*
		Post Test	70.28	24.10				
6.	PF1Z	Pre Test	469.39	92.06	2721.43	349697.57	5105.41	4.60*
		Post Test	449.37	80.00				
7.	TPF2X	Pre Test	1.28	0.76	80.24	362.24	6438.46	6.32*
		Post Test	3.69	1.45				
8.	TPF2Y	Pre Test	1.88	0.41	29.24	33.44	854.98	11.28*
		Post Test	2.40	0.91				
9.	TPF2Z	Pre Test	1.59	0.90	76.22	320.58	5809.49	6.46*
		Post Test	3.90	1.57				
10.	TPF1X	Pre Test	6.81	1.60	38.58	91.90	1488.42	5.73*
		Post Test	6.92	1.79				
11.	TPF1Y	Pre Test	7.05	1.21	53.24	204.09	2834.50	4.95*
		Post Test	6.87	1.95				
12.	TPF1Z	Pre Test	5.97	1.04	32.18	44.65	1035.55	9.18*
		Post Test	5.94	0.76				

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

The analysis of data in Table 1 documents the mean, standard deviation and 't' ratio of kinetic (ground reaction force) variables PF2X, PF2Y, PF2Z, PF1X, PF1Y, PF1Z TPF2X,TPF2Y, TPF2Z, TPF1X, TPF1Y and TPF1Z recorded at pre test and post test. According to the table the mean and standard deviation of PF2X pre test was 29.27± 13.04 and post test was 23.58 ± 12.07, with significant 't' ratio (t= 8.76) at.05 level. Mean and standard deviation of PF2Y pre test was 44.63 ± 28.27 and post test was 77.35 ± 29.52 with significant 't' ratio (t= 4.78) at.05 level. Mean and standard deviation of PF2Z pre test was 331.79 ± 112.25 and post test was 333.99 ± 66.75 with significant 't' ratio (t= 7.87) at.05 level. Mean and standard deviation of PF1X pre test was 49.77 ± 29.51 and post test was 35.16 ± 25.58 with significant 't' ratio (t= 7.27) at.05 level. Mean and standard deviation of PF1Y pre test was 45.72 ± 25.12 and post test was 70.28 ± 24.10 with significant 't' ratio (t= 6.60) at.05 level. Mean and standard deviation of PF1Z pre test was 469.39 ± 92.06 and post test was 449.37 ± 80.00 with significant 't' ratio (t= 4.60) at.05 level. Mean and standard deviation of TPF2X pre test was 1.28 ± 0.76 and post test was 3.69 ± 1.45 with significant 't' ratio (t= 6.32) at .05 level. Mean and standard deviation of TPF2Y pre test was 1.88 ± 0.41 and post test was 2.40 ± 0.91 with significant 't' ratio (t= 11.28) at.05 level. Mean and standard deviation of TPF2Z pre test was 1.59 ± 0.90 and post test was 3.90 ± 2.57 with significant 't' ratio (t= 6.46) at .05 level. Mean and standard deviation of TPF1X pre test was 6.81 ± 1.60 and post test was 6.92 ± 1.79 with significant 't' ratio (t= 5.73) at.05 level. Mean and standard deviation of TPF1Y pre test was 7.05 ± 2.21 and post test was 6.87 ± 1.95 with significant 't' ratio (t= 4.95) at.05 level. Mean and standard deviation of TPF1Z pre test was 5.97± 1.04 and post test was 5.94 ± 0.76 with significant 't' ratio (t= 9.18) at.05 level.

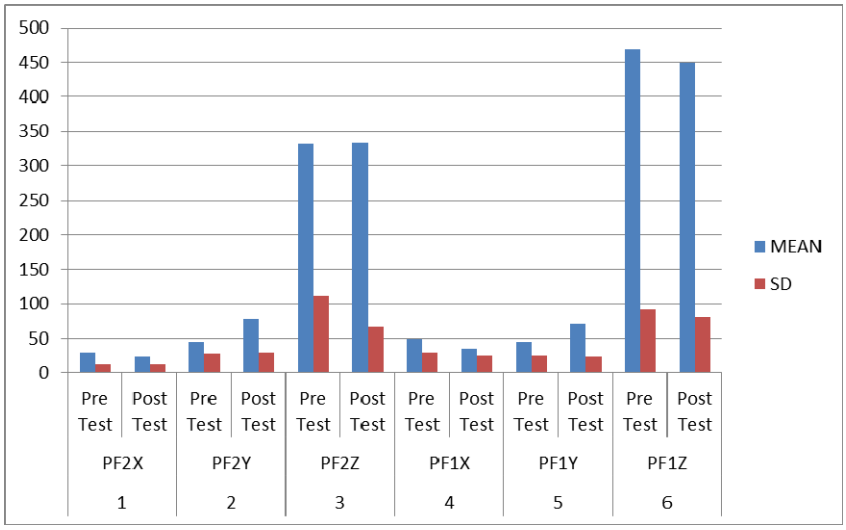

Fig 2: Training Effects on Ground Reaction Force (GRF)

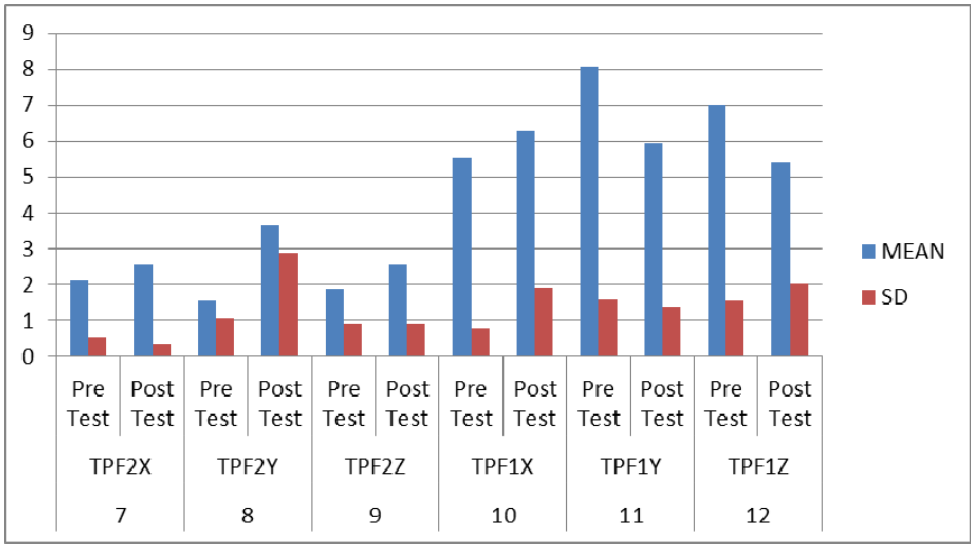

Fig 3: Training Effects on Temporal Characteristics on Ground Reaction Force (GRF)

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 6" height (PF2X) was significantly decreased.
5. Peak Force in y-axis on Force Plate 2 mounted on logs of wood at 6" height (PF2Y) was significantly increased.
6. Peak Force in z-axis on Force Plate 2 mounted on logs of wood at 6" 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 increased.
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 decreased.
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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