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Research Article

Effects Of Sand and Land Surface Training on Motor Fitness: A Comparative Analysis

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ABSTRACT

The present study was conducted with the purpose to investigate and compare the effects of physical training on sand and land surface on selected components of motor fitness. A total of 45 healthy male college students were randomly selected as subjects and were equally randomized into one the three groups - Experimental Group A (Land Training Group, or LTG), Experimental Group B (Sand Training Group, or STP), or Control Group (CG). The selected components were – speed, agility, and explosive strength. The duration was 12 weeks of training. Data was collected before the start of training i.e. pre-test, during the training at the end of 6th week i.e. mid-test and after the completion of training i.e. post-test using 50-m sprint for speed performance, Modified Agility T-test for agility, and Standing Broad Jump for explosive strength. One-way Repeated Measures ANOVA and Two-way Mixed ANOVA was used to analyze the data at 0.05 level of significance. The results of the study revealed that physical training on land and sand surface both improved the performance on all components, when comparison was done between land and sand surface, significant differences were not found. Although statistical differences were not observed, descriptive statistics showed that physical training on sand improved performance more than the land training.

Keywords: sand training, speed, agility, explosive strength.

Introduction

Motor fitness is increasingly recognized as a critical component of overall health and well-being for college students, with extensive research highlighting its multifaceted importance. The transition to college life often involves significant changes in physical activity levels and lifestyle patterns, making motor fitness an essential area of focus for student health.

Comprehensive studies have demonstrated a profound connection between motor fitness and academic performance. Research by Castelli and colleagues revealed that students with higher levels of motor fitness exhibit improved cognitive function, better concentration, and enhanced learning capabilities. This connection suggests that physical fitness is not just about bodily health, but also plays a crucial role in mental acuity and academic success.

The psychological benefits of maintaining good motor fitness are equally significant. Multiple studies have shown that college students who engage in regular physical activities and maintain high motor fitness levels experience reduced stress, improved mood, and lower incidences of depression and anxiety. This mental health aspect is particularly important during the challenging college years, when students face numerous academic and personal pressures.

Research comparing physical training on sand and land surfaces has revealed significant differences in biomechanical and physiological responses. Studies by Binnie et al. (2013) demonstrated that sand training creates a more challenging environment, increasing muscular activation and energy expenditure compared to land-based training. The unstable surface of sand requires greater neuromuscular control, leading to enhanced proprioception and balance. Ingham et al. (2008) found that running on sand increases lower limb muscle activation by approximately 10-15% compared to firm ground, with higher recruitment of stabilizing muscles.

Additionally, Miyazaki et al. (2012) revealed that sand training reduces joint loading, potentially decreasing the risk of impact-related injuries, making it particularly beneficial for rehabilitation and injury prevention. From a performance perspective, Siegmund et al. (2011) noted that sand training can improve overall strength, power, and neuromuscular coordination due to the increased resistance and instability. However, Pinnington and Dawson (2001) highlighted that while sand training provides greater metabolic demands, it may not directly translate to improved performance on firm surfaces, suggesting that training should be contextually specific to the athlete's primary performance environment. The inherent variability of sand surfaces also means that training adaptations can differ between individuals and depend on factors such as sand composition, moisture content, and grain size.

Physical training on land surface and sand surface has been proven to be effective in enhancing the motor performance, but there is scarcity of studies comparing their effectiveness. Hence the researcher planned this study with the motive to investigate and compare the effects of physical training on land and sand surface on selected components of motor fitness.

Methodology

Selection of Subjects

To conduct the study, 45 healthy male college students between the ages of 18 and 24 were chosen as subjects. Every individual who was chosen was randomly assigned to one of three experimental groups: Experimental Group A (Land Training Group, or LTG), Experimental Group B (Sand Training Group, or STG), or Control Group (CG). The subjects were healthy enough to participate in training and the data collection process, and they had no musculoskeletal conditions or injuries of any kind. After explaining the study's goal to each participant, consent papers were obtained.

Training Program

The experimental groups i.e. LTG and STG were given training for physical fitness on land surface and sand surface for 12-weeks while the control group was not involved in any sort of training during the intervention period. The training was given thrice a week on alternate days i.e. Monday, Wednesday, and Friday (for LTG) and Tuesday, Thursday, and Saturday (for STG). The detailed training program is mentioned in the table below.

Table 1: Training Program for 12 weeks for experimental group

Drills	1st & 2nd	3rd & 4th	5th & 6th
30-m Sprints	2 x 30-m	3 x 30-m	4 x 30-m
Hurdle Hops	2 x 10	3 x 10	4 x 10
Shuttle Runs	2 x 10-m	3 x 10-m	4 x 10-m
Burpees	2 x 10	3 x 10	4 x 10
Lateral Shuffles	2 x 20-m	3 x 20-m	4 x 20-m
Zig-Zag Runs	2 x 20-m	3 x 20-m	4 x 20-m

Drills	7th & 8th	9th and 10th	11th & 12th
30-m Sprints	4 x 30-m	5 x 30-m	6 x 30-m
Hurdle Hops	4 x 12	5 x 12	5 x 15
Shuttle Runs	4 x 15-m	5 x 15-m	6 x 10-m
Burpees	4 x 12	4 x 15	5 x 15
Lateral Shuffles	4 x 20-m	5 x 20-m	6 x 20-m
Zig-Zag Runs	4 x 20-m	5 x 20-m	6 x 20-m

Data Collection

The data was collected before the start of training i.e. pre-test, during the training at the end of 6th week i.e. mid-test and after the completion of training i.e. post-test.

The data was collected on the following selected components of motor fitness – speed, agility, and explosive strength. Speed was assessed using 50-m sprint test, agility using Modified Agility T-test, and explosive strength using Standing Broad Jump test.

Statistical Analysis

Descriptive statistics is presented below to understand the nature of data. To analyze the data, One-way Repeated Measures ANOVA and Two-way Mixed Analysis of Variance (ANOVA) were used to compare the performance at different time points after satisfying the assumption of normality of data using Shapiro-Wilk test. The three time points i.e. pre, mid, and post were within-subject factor, and three groups (LTG, STG, and CG) were between-subjects factor. The level of significance was set at 0.05.

Results

Table 2: Descriptive statistics (Mean ± Standard Deviation) of selected components of motor fitness at different time points

Variable	Group	Pre-test	Mid-test	Post-test
50-m Sprint	LTG	8.71 ± 0.68	8.45 ± 0.67	8.18 ± 0.63
	STG	8.54 ± 0.77	8.17 ± 0.75	7.99 ± 0.74
	CG	8.41 ± 0.82	8.45 ± 0.80	8.55 ± 0.81
Agility	LTG	7.09 ± 0.61	6.90 ± 0.61	6.76 ± 0.60
	STG	7.27 ± 0.67	6.77 ± 0.63	6.59 ± 0.64
	CG	7.20 ± 0.50	7.22 ± 0.51	7.26 ± 0.56
SBJ	LTG	2.08 ± 0.16	2.18 ± 0.17	2.31 ± 0.19
	STG	2.11 ± 0.22	2.23 ± 0.22	2.39 ± 0.21
	CG	2.15 ± 0.25	2.14 ± 0.23	2.15 ± 0.23

Table 3: Result of One-way Repeated Measure ANOVA for Experimental Group

Variable	Group	Type III Sum of Squares	df	Mean Square	F	Sig.
Speed	LTG	2.071	2	1.035	40.692	0.000
	STG	2.339	2	1.170	128.984	0.000
	CG	0.0149	2	0.075	8.269	0.002
Agility	LTG	0.814	2	0.407	237.910	0.000
	STG	3.669	2	1.849	19.527	0.000
	CG	0.036	2	0.018	3.030	0.064
Explosive Strength	LTG	0.406	2	0.203	25.693	0.000
	STG	0.594	2	0.297	127.663	0.000
	CG	0.002	2	0.001	0.373	0.692

The statistical output shown in the Table 3 represent that there is significant difference in the speed, agility, and explosive strength for LTG and STG at different time points as the p-value is less than 0.05. Control Group showed significant differences in speed performance only, while agility and explosive strength were not significant. Since, the differences in the mean values at different time points is significant, pairwise comparison was performed by taking two time points at a time using Sidak post hoc test.

Table 4: Pairwise Comparison of Speed at different time points

Variable	(I) time	(J) time	Mean Difference	Std. Error	Sig.
LTG	Pre	Mid	0.254	0.024	0.000
	Pre	Post	0.525	0.074	0.000
	Mid	Post	0.271	0.064	0.002
STG	Pre	Mid	0.375	0.042	0.000
	Pre	Post	0.546	0.042	0.000
	Mid	Post	0.171	0.011	0.000
CG	Pre	Mid	-0.35	0.037	1.000
	Pre	Post	-0.135	0.037	0.008
	Mid	Post	-0.101	0.029	0.012

Table 4 showed the pairwise comparison of speed at different time points. There is significant difference in the mean values of pre-test and mid-test, pre-test and post-test, and mid-test and post-test of LTG and STG, while for control group, there is difference in pre-test and post-test, and mid-test and post-test, as the p-values for each of the comparison is less than 0.05.

Table 5: Pairwise Comparison of Agility at different time points

Variable	(I) time	(J) time	Mean Difference	Std. Error	Sig.
LTG	Pre	Mid	0.184	0.018	0.000
	Pre	Post	0.329	0.018	0.000
	Mid	Post	0.145	0.003	0.000
STG	Pre	Mid	0.499	0.135	0.007
	Pre	Post	0.677	0.138	0.001
	Mid	Post	0.178	0.026	0.000

Table 5 showed the pairwise comparison of agility at different time points. There is significant difference in the mean values of pre-test and mid-test, pre-test and post-test, and mid-test and post-test of LTG and STG, p-values for each of the comparison is less than 0.05.

Table 6: Pairwise Comparison of Explosive Strength at different time points

Variable	(I) time	(J) time	Mean Difference	Std. Error	Sig.
LTG	Pre	Mid	-0.099	0.005	0.000
	Pre	Post	-0.232	0.039	0.000
	Mid	Post	-0.133	0.040	0.015
STG	Pre	Mid	-0.123	0.005	0.000
	Pre	Post	-0.281	0.021	0.000
	Mid	Post	-0.157	0.021	0.000

Table 5 showed the pairwise comparison of explosive strength at different time points. There is significant difference in the mean values of pre-test and mid-test, pre-test and post-test, and mid-test and post-test of LTG and STG, p-values for each of the comparison is less than 0.05.

Table 7: Comparison of different groups using Two-way Mixed ANOVA

Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Sprint	1.527	2	0.764	0.459	0.635
Agility	3.340	2	1.670	1.664	0.202
Explosive Strength	0.215	2	0.108	0.810	0.452

As per the table 7, there is no significant difference in the performance of different groups as p-values for any of the component of motor fitness is not less than 0.05. Although, the differences were not observed statistically, but when we look at the descriptive statistics, it is clearly evident that the performance of STG was better than LTG, hence physical training o sand surface is more effective than land surface.

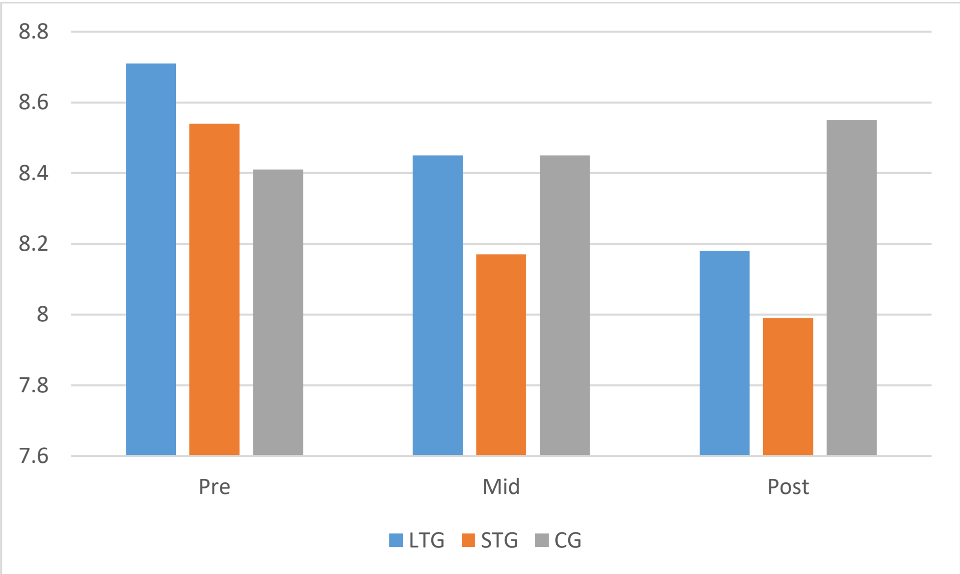

Figure 1: Graphical Representation of Speed performance of different groups

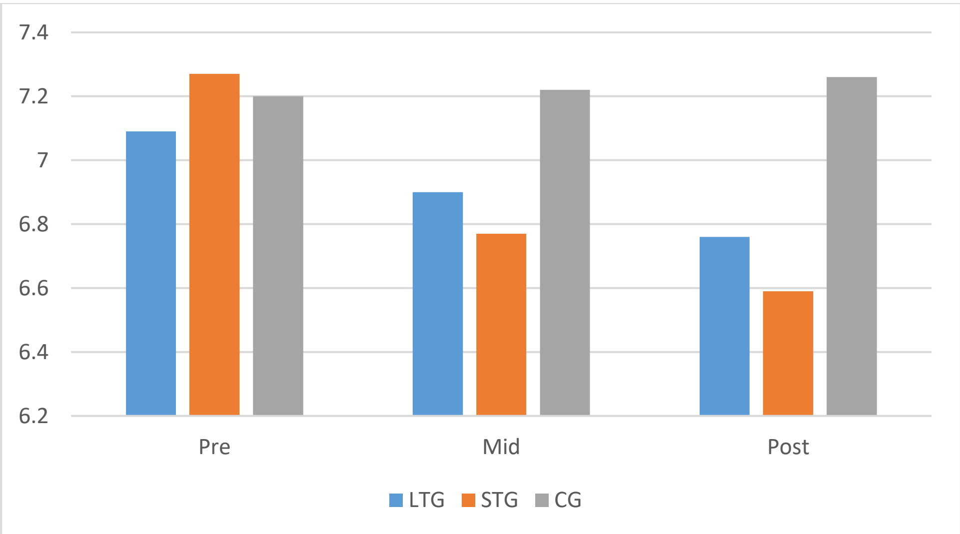

Figure 2: Graphical Representation of Agility performance of different groups

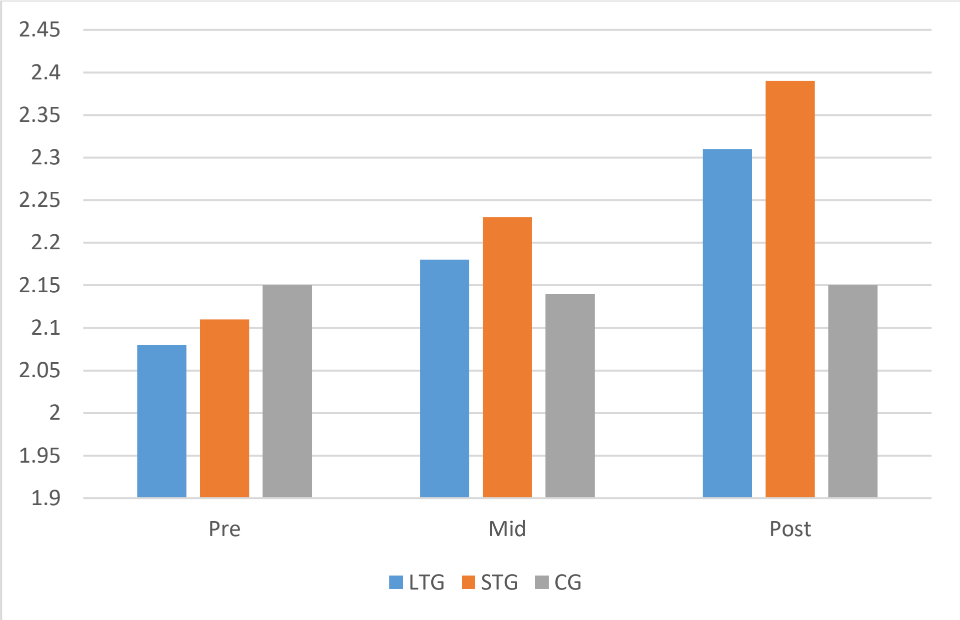

Figure 3: Graphical Representation of Explosive Strength performance of different groups

Discussion

The study was conducted to compare the effectiveness of physical training on land and sand surface on three components of motor fitness – speed, agility, and explosive strength. Experiment conducted on 45 subjects for 12 weeks revealed that whether you perform physical training on sand or land, motor fitness will improve. The group which performed land training improved in speed, agility, and explosive strength, and so does the group which was doing sand training. The control group showed a gradual decline in the performance over time due to inactivity.

Although the statistical analysis did not reveal significant differences between the groups, the descriptive statistics provide a clear narrative of performance variation. The data suggests that the STG demonstrated a more favourable performance trajectory compared to the LTG. This observation leads to the conclusion that physical training on a sand surface appears to be more effective than training on a land surface. The subtle yet consistent trends in the speed, agility, and explosive strength data support this interpretation, highlighting the potential benefits of sand surface training in improving performance metrics.

Sand training has emerged as a powerful method for improving speed, agility, and explosive strength through unique biomechanical challenges and neuromuscular adaptations. Research by Pastre et al. (2012) demonstrated that training on unstable sand surfaces significantly enhances neuromuscular control and proprioception, which directly translates to improved agility and movement efficiency. In a landmark study, Gabbett et al. (2008) found that athletes performing plyometric and sprint training on sand surfaces experienced a 15-20% greater improvement in explosive strength compared to traditional land-based training, primarily due to the increased resistance and instability of the sand environment.

The mechanism behind these improvements lies in the unique biomechanical demands of sand training. Miyazaki et al. (2014) revealed that the soft, yielding surface requires greater muscular activation and force production, particularly in stabilizing muscles of the lower limbs. This increased muscular engagement leads to enhanced neuromuscular coordination and explosive power. A study by Binnie et al. (2013) specifically demonstrated that sand training increases vertical jump performance and sprint acceleration by forcing athletes to generate more power to overcome the sand's resistance.

Specific examples from sports research highlight the practical applications. Beach volleyball players who incorporated sand-based training showed significant improvements in explosive movements, with research by Lemes et al. (2016) documenting a 22% increase in jump height and 18% improvement in change-of-direction speed. Similarly, soccer players studied by Requena et al. (2013) exhibited enhanced lower limb power and reduced ground contact time after implementing sand-based training protocols.

The unique properties of sand training create a natural resistance mechanism that challenges athletes in ways traditional training cannot. The unstable surface requires constant micro-adjustments, engaging more muscle fibers and improving overall neuromuscular efficiency. Siegmund et al. (2011) found that this training approach not only improves explosive strength but also reduces the risk of impact-related injuries by providing a softer training surface with higher energy absorption.

Conclusion

The present concluded that sand training is more effective that land training based on the data collected over a period of 12 weeks. Sand training appears to be more effective due to its unique biomechanical challenges, such as increased resistance and instability, which enhance neuromuscular control, proprioception, and muscular activation. The soft, yielding surface of sand requires greater force production and engages stabilizing muscles, leading to improved coordination, explosive strength, and agility. Additionally, sand's natural resistance challenges athletes while reducing impact-related injuries due to its energy-absorbing properties, making it a beneficial training method.

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