EFFECT OF SURYANAMASKAR ON VITAL CAPACITY OF SCHOOL GIRLS: A MIXED DESIGN APPROACH

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ABSTRACT
The objectives of the study were to determine the main effect of training durations (within-groups), the main effect of groups (between-groups) and interaction effect (combined effect of training durations and groups) on vital capacity due to practices of Suryanamaskar. Mixed design was used for study. Four groups were created, three experimental and one control group. 10 girls were in each group in the range of 15 – 17 years. First experimental group performed one round of Suryanamaskar in 1 minute pace, second experimental group in 2 minutes, third experimental group in 4 minutes and fourth group served as a control group. Total treatment duration was six weeks. Vital capacity was measured by Dry Spirometer in litters before (pretest) after 3 weeks and after 6 weeks of all four groups. 4 x 3 mixed factorial ANOVA was used and level of significance was set at 0.05. There were significant effects of training durations, groups (paces) and interaction effect on vital capacity. Interaction effect confirmed that practice of Suryanamaskar for six weeks are sufficient to bring out significant improvement on vital capacity with pace 1 and pace 4. It also concluded that Suryanamaskar practice for 6 weeks with pace 1 help to improve better vital capacity as compare pace 1, pace 4 and control group. The beneficial effects of Suryanamaskar practices (with pace 1) is as similar as aerobic workout. It can be applied to all schools to improve the physical health and sports activities of the students.
Keywords: Practice, Pace, Yoga and Vital Capacity.

INTRODUCTION
Suryanamaskar is a well know and vital technique with the yogic repertoire. It is versatility and application make it one of the most useful methods to induce a healthy, vigorous, active life and at the same time prepare for spiritual awakening and the resultant of awareness.(Saraswati, Swami, 2009). Suryanamaskar or sun salutation is a traditional Indian yogic practice, renders the benefits of stretching, static, and dynamic exercise. Each round of Suryanamaskar practice involves practicing 12 postures in succession with forward and backward bending along with deep exhalation and inhalation respectively to the maximum possible extent. Many people practice several rounds of Suryanamaskar for their regular physical fitness program. Vital capacity is defined as the largest volume of air that can be exhaled after the deepest possible inhalation. It is equal to the sum of inspiratory reserve volume, tidal volume and expiratory reserve volume. The one of the best method to improve efficiency of vital capacity is aerobic workout. Aerobic actives improve aerobic metabolism of the body, which improve efficiency of circulatory and respiratory systems. Sound mind lives in a sound body. As we know that the children are the bank of energy and they know as a synonym of motion. It is much heard to teach them yoga or more specific yogic asana those are static in nature. Suryanamaskar is a yogic practice which is dynamic in nature and gives benefits at all level of fitness (physical, mental, emotional and spiritual), Suryanamaskar is a complete yogic practice physical level or in other words we can say that Suryanamaskar is the one of the best mean to improve physical fitness of an individual. There are plenty of studies have been done to see the effect of yogic asanas on physical and physiology variables. Suryanamaskar is itself combination of six asanas. (Shankar and

Pancholi, 2011). Going through many research papers this query has been raised that change in the pace of Suryanamaskar effect on vital capacity (Bhavanani, 2011).

METHODS

Subjects:

The subjects for this study were selected from the Kiddy's Corner School, Gwalior. Forty eight girls in the range of 15 – 17 years from class 11th and 12th were selected randomly for this study. Only forty girls were able to complete 6 weeks Suryanamaskar practices.

Variables: Suryanamaskar was considered as independent variable and vital capacity was considered as dependent variable.

Test for Vital Capacity: Vital capacity was measured with the help of Dry Spirometer. It was ensured that the pointer of the scale was at the zero mark at the beginning of the test. The subject took a deep breath before starting the test, and then after the fullest inhalation the subject placed the mouthpiece attached to the hose connected to the air, escaped through the edges of the mouthpiece. The subject exhaled slowly and steadily while bending forward slightly until the maximum volume of air was expelled without taking a second breath. The subjects were instructed that they should blow out only through the mouth not by the nose. Out of three observations best one count as a final score.

Experimental Design:

Mixed-Model design (between-within group design) was used for the study. The experimental treatment was assigned randomly into four groups and one group served as a control group out of four groups. 12 girls were in each group.The data was collected from all the four groups (three experimental and one control group) before the training (pre-test), after 6 weeks and after 12 weeks training of Suryanamaskar. First experimental group preformed one round of Suryanamaskar in 1 minute pace, second experimental group performed in 2 minute pace, third experimental group perform in pace 4 and fourth group served as a control group. Total treatment duration was six weeks.

TABLE NO 1
EXPERIMENTAL DESIGN

		TIME DURATION		
		Pretest (0)	**3 weeks**	**6weeks**
GROUPS	**Pace 1**	$P_1$0	$P_1$3	$P_1$6
	Pace 2	$P_2$0	$P_2$3	$P_2$6
	Pace 4	$P_4$0	$P_4$3	$P_4$6
	Control	C0	C3	C6

All participants were briefed introduced about general objectives and requirement of Suryanamaskar. Suryanamaskar training was carried for a period of six weeks, five days per week between 01-09-2013 to 20-10-2013. The scheduled time of practice was during their physical education period for 40-45 minutes. Suryanamaskar practice was demonstrated to the group by the research scholar and most important points were reviewed several times. The pace of Suryanamaskar was control by watch. To determine the effect different paces of Suryanamaskar on vital capacity on school girls 4 x 3 between-within factorial ANOVA and level of significant was set at 0.05.12 steps of Suryanamaskar are following (Saraswati, Swami, 2002).

RESULTS

TABLE NO.2
TESTS OF WITHIN-SUBJECTS EFFECTS FOR TRAINING DURATIONS AND INTERACTION

Source	Type III Sum of Squares	Df	Mean Square	F	p-value	Partial Eta Squared
Duration	3.483	2	1.742	56.058	.000	.602
Durations x Groups	1.352	6	.225	7.253	.000	.370

Above table shows that there was a significant main effect of training durations on vital capacity as the p-value was 0.00 which was less than 0.05. It also shows that there was a significant interaction effect between groups and training durations as the p-value was 0.00 which was less than 0.05.Partial eta2 in the above table explains 60% of variance of training durations and 37% of variance was explained by the interaction, which shows variance of interaction between training durations and groups. Partial eta2 of training duration and interaction indicate very large effect size.

TABLE NO.3
TESTS OF BETWEEN-SUBJECTS EFFECTS FOR GROUPS

Source	Type III Sum of Squares	Df	Mean Square	F	p-value	Partial Eta Squared
Intercept	586.393	1	586.393	2599.067	.000	.986
Groups	1.973	3	.658	2.914	.047	.191
Error	8.348	37	.226			

*Significant at the 0.05 level.

Above table shows that there was a significant difference found among gropes (pace 1, pace 2, pace 4 and control group) on their vital capacity due to Suryanamaskar practice as the p-value was less than 0.05.Partial eta^2 in the above table explains 19% of variance of groups, which indicated medium effect size. It has been concluded from the above table 3 and 4 that there was a significant effect of training durations on vital capacity and also significant difference found on vital capacity among groups (experimental groups and control group). Table of within subjects effects (Table 3) indicated that there was a significant interaction effect between training durations and groups on vital capacity. To know in detail about how vital capacity improved in each of the group through the practices of Suryanamaskar, one way AVOVA with repeated measures is employed separately for each group. Further multiple ANOVA's were also computed separately for each data readings (pre test, after 3 weeks and after 6 weeks).

If multiple one ANOVA's and multiple repeated measure ANOVA's were applied, the error would be inflated in multiplying rate. If level of significance chosen was 0.05 and number of repeated measure ANOVA's were four and number One Way ANOVA's were three. Thus, the significance of F for groups (between groups) in three experimental groups and control group were tested at 0.0125 (= 0.05/4) level. Similarly in testing the significance of training durations(with groups) in each duration of pre test, after 3 weeks and

after 6 weeks were tested at 0.017 (= 0.05/3). In the further interpretation of the results of one way repeated measure ANOVA's and One Way ANOVA's employed the above obtained adjusted α is considered, though it is reported to be significant at 0.05 level of significance.

Interaction Effect (Training Durations X Groups)

Mauchly's Test of sphericity for different groups were calculated and shown in the table underneath

TABLE NO. 04

MAUCHLY'S TEST OF SPHERICITY FOR WITH-IN GROUPS

Within Subjects Effect	Mauchly's W	Chi-Square	df	p-value	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Pace 1	.765	2.148	2	.342	.809	.961	.500
Pace 2	.822	1.568	2	.457	.849	1.000	.500
Pace 4	.601	4.079	2	.130	.715	.812	.500
Control	.509	6.070	2	.048	.671	.737	.500

*Significant at the 0.0125 level.

From the above table it was evident that assumption of sphericity was fulfilled in all experimental groups because p-value was more than 0.05 in all groups. Above table also evident that the assumption of sphericity was violated in control group because p value was less than 0.05. Adjusted α level 0.0125 was the corrected level of significance which is to be considered for p-value. For the purpose of interpreting One-way repeated measure ANOVA's applied on training groups separately this adjusted α value was considered, though it was reported to be significant at 0.05 level of significance.

TABLE NO. 05

TESTS OF WITHIN-SUBJECTS EFFECTS

Source			Type III Sum of Squares	Df	Mean Square	F	p-value	Partial Eta Squared
Groups	Pace 1	Sphericity Assumed	3.203	2	1.601	57.95	.000	.866
	Pace 2	Sphericity Assumed	.546	2	.273	2.670	.097	.229
	Pace 4	Sphericity Assumed	.942	2	.471	15.37	.000	.631
	Control	Greenhouse-Geisser	.102	1.34	.076	2.414	.139	.194
Error	Pace 1	Sphericity Assumed	-.064	.07	1.00			
	Pace 2	Sphericity Assumed	1.841	18	.102			
	Pace 4	Sphericity Assumed	.551	18	.031			
	Control	Greenhouse-Geisser	.424	13.41	.032			

*Significant at the 0.0125 level.

Above table evident that there was significant effect of training durations on pace 1 group and pace 4 group as the p-value was less than 0.0125. Above table also evident that there was no significant effect of training durations on pace 2 group and control group as the p-value was more than 0.0125. This means training duration had a significant effect on pace 1 and pace 4 experimental groups. To know exactly in which time period (pre test, after 3 weeks, after 6 weeks) of training durations vital capacity was improved significantly, pair-wise comparisons between data readings after Bonferroni correction for confidence interval was done. The results are shown in the table below.

TABLE NO.6

PAIR WISE COMPARISONS OF TIME DURATION (WITHIN GROUPS)

Groups	(I) time	(J) time	M.D.	S.E.	p-value	95% Confidence Interval for Difference	
						Lower Bound	Upper Bound
Pace 1	Pre test	3 weeks	-.380*	.053	.000	-.536	-.224
		6 weeks	-.800*	.083	.000	-1.043	-.557
	3 weeks	Pre test	.380*	.053	.000	.224	.536
		6 weeks	-.420*	.083	.002	-.663	-.177
Pace 2	Pre test	3 weeks	-.180	.156	.837	-.638	.278
		6 weeks	-.330	.158	.201	-.795	.135
	3 weeks	Pre test	.180	.156	.837	-.278	.638
		6 weeks	-.150	.109	.604	-.469	.169
Pace 4	Pre test	3 weeks	-.030	.088	1.000	-.289	.229
		6 weeks	-.390*	.091	.006	-.658	-.122
	3 weeks	Pre test	.030	.088	1.000	-.229	.289
		6 weeks	-.360*	.048	.000	-.500	-.220
Control	Pre test	3 weeks	-.064	.077	1.000	-.283	.156
		6 weeks	-.136	.066	.202	-.327	.054
	3 weeks	Pre test	.064	.077	1.000	-.156	.283
		6 weeks	-.073	.036	.211	-.176	.030

*Significant at the 0.0125 level.

Table shows that in pace 1group there was significant difference found between pretest and after 3 weeks, between pretest and after 6 weeks and after 3 week and after 6 weeks as the p-value was less than 0.05 (0.0125).In pace 4 group there was significant difference found between pretest and after 6 weeks and between after 3 weeks and 6 weeks as the p-value was less than 0.05(0.0125). There was no significant differences found between pretest and after 6 weeks as the p-value was greater than 0.05(0.0125).In pace 2 and control group there were no significant difference found between pretest and after 3 weeks, pretest and after 6 weeks, 3 weeks and after 6 weeks as the p-value was greater than 0.05 (0.0125).

From table 3 it was found that there was an interaction between training duration and groups. To know if there was a difference between training groups in each of the data readings, one way ANOVA was computed separately for all the data readings. The results are shown below.

TABLE NO.07
BETWEEN GROUP ANOVA

Time		Sum of Squares	Df	Mean Square	F	p-value
Pretest	Between Groups	0.051	3	.017	.300	.825
	Within Groups	2.088	37	.056		
	Total	2.139	40			
3 weeks	Between Groups	.682	3	.227	1.703	.183
	Within Groups	4.940	37	.134		
	Total	5.622	40			
6 weeks	Between Groups	2.592	3	.864	8.834	.000
	Within Groups	3.618	37	.098		
	Total	6.210	40			

*Significant at the 0.017 level.

The results of One-Way ANOVA indicate that scores of vital capacity was not different in pre test and after 3 weeks of the data readings among four groups as the p-value was greater than 0.05(0.017). There was significance difference found among four groups at 6 weeks because p-value (0.000) was less than 0.05 (adjusted α level 0.017). Since the one way ANOVA of vital capacity was found significant among groups at the end of 6 weeks, therefore Tukey post hoc test was applied, to know exactly which group was between than which group. The results are shown in the table below.

TABLE NO.08
PAIR WISE COMPARISONS OF WITHIN GROUPS (12 WEEKS)

Dependent Variable	(I) Groups	(J) Groups	M.D. (I-J)	S.E.	p-value	95% Confidence Interval	
						Lower Bound	Upper Bound
6 weeks	Pace1	pace2	.47000*	.13985	.009	.0938	.8462
		pace4	.34000	.13985	.089	-.0362	.7162
		Control	.68909*	.13663	.000	.3216	1.0566
	Pace2	pace1	-.47000*	.13985	.009	-.8462	-.0938
		pace4	-.13000	.13985	.789	-.5062	.2462
		Control	.21909	.13663	.389	-.1484	.5866
	Pace4	pace1	-.34000	.13985	.089	-.7162	.0362
		pace2	.13000	.13985	.789	-.2462	.5062
		Control	.34909	.13663	.068	-.0184	.7166
	Control	pace1	.47000*	.13985	.009	.0938	.8462
		pace2	.34000	.13985	.089	-.0362	.7162
		pace4	.68909*	.13663	.000	.3216	1.0566

*Significant at the 0.017 level.

Above table indicates that significant difference found between pace 1 group and control group and between pace 1 and pace 2 group as the p-value was less than 0.05($p < 0.017$). There was no significant difference found between pace 1 and pace 4 group, between pace 2 and pace 4 group and between pace 2 and control group. On the basis of above tables we concluded that practice of Suryanamaskar for 6 weeks are sufficient to bring out significant improvement on vital capacity with any pace 1 and pace 4. On the basis on descriptive table we concluded that Suryanamaskar practice with pace 1 help to improve maximum vital capacityas compare pace 2 and pace 4.

DISCUSSION

The objectives of the study were to determine the main effect of training durations (within-groups), the main effect of groups (between-groups) and interaction effect (training durations x groups) on vital capacity due to practices of Suryanamaskar. The finding of the study revealed that there was significant effect of training durations on pace 1 group and pace 4 group as the p-value was less than 0.0125. Above table also evident that there was no significant effect of training durations on pace 2 group and control group as the p-value was more than 0.0125. This means training duration had a significant effect on pace 1 and pace 4 experimental groups. There was also significant difference found on vital capacity among groups. This finding is in agreement with the results of (Kumar et al., 2011). Table of within subjects effects (Table 3) indicated that there was a significant interaction effect between training durations and groups on vital capacity. To know in detail about how vital capacity improved in each of the group through the practices of Suryanamaskar, one way AVOVA with repeated measures is employed separately for each group. Further multiple ANOVA's were also computed separately for each data readings (pre test, after 3 weeks and after 6 weeks).

Basically the key method for improvement in vital capacity is regular aerobic workout. Regular aerobic workout strengthens and tones the heart and lungs, enabling the pulmonary system to increase the maximum amount of oxygen that the lungs can handle, according to the Merck Manuals online medical library. Fast-moving exercise causes your heart and breathing rates to increase, delivering fresh oxygen to your bloodstream and energy to your muscles. Your lung capacity can be increased through regular aerobic workouts, but only by a modest amount, according to Dr. Tim Noakes, author of "The Lore of Running." Aerobic actives improve aerobic metabolism of the body, which improve efficiency of circulatory and respiratory systems. Same way practices of Suryanamaskar with medium intensity for 30 to 35 minutes help to improve aerobic metabolism, during aerobic metabolism body required more oxygen which improve the efficiency pulmonary system or we can say vital capacity improved due to regular practice of Suryanamaskar. In this way present study concluded that practice of Suryanamaskar for 6 weeks are sufficient to bring out significant improvement on vital capacity with pace 1 and pace 4 of Suryanamaskar. On the basis on descriptive table we concluded that Suryanamaskar practice with pace 1 help to improve maximum vital capacity as compare pace 2 and pace 4. The beneficial effects of Suryanamaskar practices (with pace 1) is as similar as aerobic workout. It can be applied to all schools to improve the physical fitness and sports activities of the students.

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