

EFFECT OF SURYANAMASKAR ON MUSCULAR ENDURANCE OF SCHOOL GIRLS: A MIXED DESIGN APPROACH

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Mr. Vivek Singh

Ph.D Scholar, LNIPE, Gwalior (M.P.)

Dr. Anurodh Singh Sisodia

Associate Professor, LNIPE, Gwalior (M.P.)

**Abstract**

The objective of the study were to determine the main effect of time durations (with in groups), the main effect of different paces (between groups) and interaction effect (combined effect of time and pace) on muscular endurance due to practice of Suryanamaskar. Mixed design was used for study. Four groups were created, three experimental and one control group. 12 girls were in each group in the age group of 15 – 17 years. First experimental group performed one round of Suryanamaskar in 1 minute, 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. Muscular endurance was measured by modified push-up test in numbers before (pretest) after 3 weeks and after 6 weeks of all four groups. 4 x 3 factorial mixed ANOVA was used and level of significance was set at 0.05. There were significant effects of time duration and interaction on improvement of muscular endurance. There was no significant difference found among different paces of Suryanamaskar on muscular endurance. In this way present study confirmed that practice of Suryanamaskar for six weeks are sufficient to bring out significant improvement on muscular endurance with pace 1, pace 2 and pace 4. It also concluded that Suryanamaskar practice for 6 weeks with pace 2 help to improve maximum muscular endurance as compare pace 1, pace 4 and control group.

Keywords: Suryanamaskar, Pace and Muscular Endurance

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. Today children sit in overcrowded classrooms, cramped and bent over their books, their mind tired from too much intellectual activity. Real education is not just for the fulfillment of external, social and economic commitments, it is also for the inner understanding and the growth of the all round personality at physical, mental and spiritual. Sound mind lives in a sound body. As we know that the children are the bank of energy and they know as synonyms of motion. It is much heard to teach them yoga or more specific yogic asana that are static in nature, but Suryanamaskar is a yogic practices which is dynamic in nature and give benefits at physical level or in other words we can say that Suryanamaskar is the one of the best mean to

improve physical fitness of children. Muscular endurance is the ability of a muscle or muscle group to resist fatigue and to make repeated contractions against a defined submaximal effort (dynamic endurance). The need for muscular endurance is demonstrated in many of our daily activities. The key method for improved in muscular endurance is low resistance and high repetition. There are plenty of studies have been done to see the effect of yogic asanas on physical variables and Suryanamaskar is itself combination of six asanas. Going through many research papers this query has been raised that change in the pace of suryanamaskar effect on muscular endurance.

Objectives of the study were following:

To determine the effect of different paces (pace 1, pace 2 and pace 4) of Suryanamaskar on muscular endurance.

To determine the effect different time durations (between pretest and after 6 week, pretest and after 12 weeks and between 6 weeks and after 12 weeks) on different paces of Suryanamaskar on muscular endurance.

To investigate whether there is interaction effect (combined effect of pace and time duration) on muscular endurance due to practice of Suryanamaskar.

Methodology

The subjects for this study were selected from the Kiddy's Corner School, Gwalior. Forty eight girls in the age range of 15 – 17 years from class 11th and 12th were selected randomly for this study. Suryanamaskar was considered as independent variable and muscular endurance was considered as dependent variable. To measure arm and shoulder girdle endurance modified push-ups test was used. Subject first lies face down on the floor with the body trunk straight, knees bent at right angles, arm bend and hands flat on the floor beneath on the shoulders. Use the knees as the pivot point and pushes upward to a straight arm position. Lower the body until the chest touches the floor and repeats the exercise as many a time as possible, without rest. The body must be stay rigid throughout the test. The score was the number of correct push-ups completed. 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(pace

1) group performed one round of Suryanamaskar(12 steps) in 1 minute, second experimental group (pace 2) performed in 2 minutes, third experimental group(pace 4) performed in 4 minutes and fourth group served as a control group. Total treatment duration was six weeks. 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 1-9-2013 to 20-10-2013. The scheduled time of practice was during their physical education period for 35-40 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 muscular endurance on school girls 4 x 3 between-within factorial ANOVA and level of significant was set at 0.05. Practice of Suryanamaskar was performed according book asana pranayama mudra bannha.

Results

TABLE 1
DESCRIPTIVE STATISTICS OF MUSCULAR ENDURANCE OF DIFFERENT PACES AND TIME DURATION OF SURYANAMASKAR

Paces of S.N	Pre Test		3 Weeks		6 Weeks	
	Mean	S.D	Mean	S.D	Mean	S.D
Pace 1	14.83	3.48	15.75	3.41	17.41	2.81
Pace 2	15.16	3.92	18.50	2.71	20.58	1.62
Pace 4	14.58	3.94	17.16	3.29	18.91	2.35
Control	14.58	4.39	14.75	4.04	15.50	3.20

In table 2 Mauchly's test was applied to check the assumption of sphericity. The p-value is 0.000 which is less than 0.05, so we found that the assumption of sphericity has been violated.

TABLE 2
MAUCHLY'S TEST OF SPHERICITY

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Epsilon ^b		
				Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Time	.665	17.54	2	.74	.82	.50

After violated of sphericity assumption we used huynh-feldt correction, because epsilon value is greater than 0.75 (in table 2).

TABLE 3
TESTS OF WITHIN SUBJECTS EFFECTS

Source	Type III Sum of Squares	df	Mean Square	F	p-value	Partial Eta Squared
Time	Huynh-Feldt 263.62	1.64	160.27	64.00	.00	.59
Time*groups	Huynh-Feldt 76.48	4.93	15.50	6.19	.00	.29

In table 3 (tests of within-subjects effect) p-value is 0.000 which is less than 0.05, which indicated that there is a significant effect of time (training duration) on muscular endurance. It also shows that there is a significant interaction effect between groups and time (p < 0.05).

TABLE 4
TESTS OF BETWEEN-SUBJECTS EFFECTS

Source	Type III Sum of Squares	df	Mean Square	F	p-value
Intercept	39105.063	1	39105.063	1318.625	.000
Groups	191.743	3	63.914	2.155	.107
Error	1304.861	44	29.656		

Table 4 shows that there is no significant difference between groups on their muscular endurance due to suryanamaskar training as p-value (0.107) is greater than 0.05. It has been concluded from the above table 3 and 4 that there is a significant effect of time (training duration) on muscular endurance, but other side no significant difference found on muscular endurance between groups. To find out the effect of time in more detail pair wise mean comparisons have been computed and shown in table 5.

TABLE 5
PAIRWISE COMPARISONS

(I) time	(J) time	Mean Difference (I-J)	Std. Error	95% Confidence Interval for Difference ^b	
				Lower Bound	Upper Bound
Pretest	3 weeks	-1.750 [*]	.218	-2.292	-1.208
	6 weeks	-3.313 [*]	.364	-4.218	-2.407
3 weeks	Pretest	1.750 [*]	.218	1.208	2.292
	6 weeks	-1.563 [*]	.279	-2.256	-.869

Table 5 shows that there is a significant difference between all the training durations i.e. there is a significant difference between Pretest and 3 weeks, between 3 weeks and 6 weeks and pretest and 6 weeks duration.

Table 5 of within subjects effects indicated that there is a significant effect of interaction of duration and training groups on muscular endurance. To know in detail about how muscular endurance improved in each of the training groups through the training program, one way AVOVA with repeated measures is employed separately for each training groups. Mauchly's Test of sphericity for different training groups were calculated and shown in table 6.

TABLE 6
MAUCHLY'S TEST OF SPHERICITY

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	Df	p-value	Epsilon ^b		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Pace 1	.875	1.334	2	.513	.889	1.000	.500
Pace 2	.682	3.820	2	.148	.759	.855	.500
Pace 4	.183	17.005	2	.000	.550	.566	.500
Control	.724	3.223	2	.200	.784	.891	.500

Table 6 it is evident that the assumption of sphericity is fulfilled in pace 1, pace 2 and control groups because p value is more than 0.05 in groups. As the above table also evident that the assumption of sphericity is violated in pace 4 groups because p value is less than 0.05.

Adjusted α level 0.0073 is 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 groups separately this adjusted α value is considered, though it is reported to be significant at 0.05 level of significance.

TABLE 7
TESTS OF WITHIN-SUBJECTS EFFECTS

Source	Type III Sum of Squares	df	Mean Square	F	p-value	Partial Eta Squared
Pace 1 Sphericity Assumed	41.16	2	20.58	15.35	.00	.58
Pace 2 Sphericity Assumed	179.16	2	89.58	26.81	.00	.70
Pace 4 Greenhouse-Geisser	114.05	2	103.64	28.99	.00	.72
Control Sphericity Assumed	5.72	2	2.86	1.80	.18	.14

In table 7 shows all the three experimental (pace 1, pace 2 and pace 4) groups were found significant with P-values 0.000 as in all the cases it was less than 0.0073, but same time control group was found no significant with p-value is 0.910 which is more than 0.0073. This means training duration had a significant effect on each of the experimental groups.

To know exactly in which time period of training muscular endurance was improved significantly, pairwise comparisons between data readings after Bonferroni adjustment for confidence interval was done. The results are shown in the table below.

TABLE 8
PAIR WISE COMPARISONS OF TIME DURATION (WITHIN GROUPS)

Groups	(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	p-value	95% Confidence Interval for Difference ^b	
						Lower Bound	Upper Bound
Pace 1	Pre test	3 weeks	-.91	.39	.125	-2.03	.20
		6 weeks	-2.58*	.54	.002	-4.11	-1.05
	3 weeks	Pre test	.91	.39	.125	-.20	2.03
		6 weeks	-1.66*	.46	.013	-2.98	-.35
Pace 2	Pre test	3 weeks	-3.33*	.63	.001	-5.11	-1.55
		6 weeks	-5.41*	.93	.000	-8.04	-2.78
	3 weeks	Pre test	3.33*	.63	.001	1.55	5.11
		6 weeks	-2.08*	.63	.022	-3.86	-.29
Pace 4	Pre test	3 weeks	-2.58*	.26	.000	-3.31	-1.85
		6 weeks	-4.33*	.76	.000	-6.48	-2.18
	3 weeks	Pre test	2.58*	.26	.000	1.85	3.31
		6 weeks	-1.75*	.57	.035	-3.38	-.11
Control	Pre test	3 weeks	-.16	.36	1.000	-1.19	.86
		6 weeks	-.91	.60	.481	-2.63	.80
	3 weeks	Pre test	.16	.36	1.000	-.86	1.19
		6 weeks	-.75	.53	.573	-2.26	.76

Table 8 shows that in pace 1 group there is no significant difference found between pretest and after 3 weeks ($p = 0.125$), between 3 weeks and after 6 weeks ($p = 0.013$) which are greater than Adjusted α level 0.0073. Significant different found between pretest and after 6 weeks ($p = 0.002$) as the p-value is less than 0.05. In pace 2 and pace 4 groups table shows that there are significant difference found between pretest and after 3 weeks, between pretest and after 6 weeks as p-value is less than 0.05 and between 3 weeks and after 6 weeks no significant difference found as the p-value is greater than 0.05 (0.0073). No significant difference found in

control group between pretest and after 3 weeks, between 3 weeks and after 6 weeks' time duration because p-value is more than 0.05.

From table 3 it was found that there is an interaction between training duration (time) and groups (pace). Interaction effects are shown in detail in below tables.

To know if there is 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 9
ANOVA BETWEEN GROUPS

		Sum of Squares	df	Mean Square	F
Pretest	Between Groups	2.75	3	0.91	.059
	Within Groups	687.16	44	15.61	
	Total	689.91	47		
3 weeks	Between Groups	96.75	3	32.25	2.78
	Within Groups	509.16	44	11.57	
	Total	605.91	47		
6 weeks	Between Groups	168.72	3	56.24	8.54
	Within Groups	289.75	44	6.58	
	Total	458.47	47		

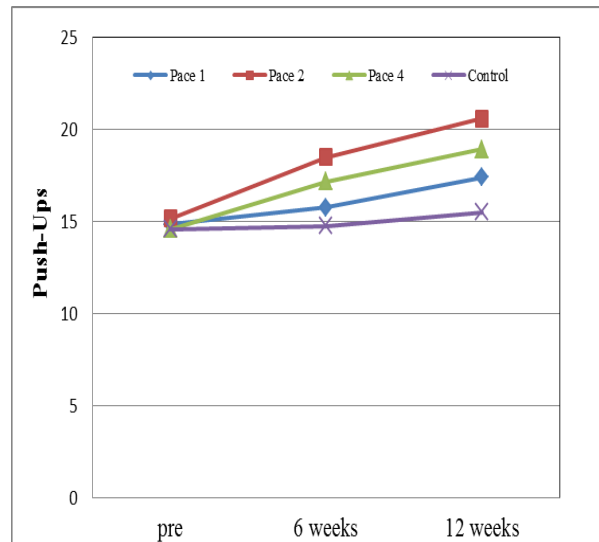
In table 9 shows that the results of One-Way ANOVA indicate that scores of muscular endurance was not different in pre test and after 3 weeks of the data readings among four groups as p-value is greater than 0.05. There was significance difference found among four groups at 6 weeks because p-value (0.000) is less than 0.05 (adjusted α level 0.0073).

Since the ANOVA for muscular endurance was found significant among groups at the end of 6 weeks, therefore bonferroni test was applied for pair wise comparisons between groups to know exactly which group has significant difference than which group. The results are shown in the table 10.

TABLE 10
PAIR WISE COMPARISONS OF TIME DURATION (WITHIN GROUPS)

Dependent Variable	(I) groups	(J) groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
6 weeks	Pace1	Pace2	-3.16*	1.04	.02	-6.06	-.27
		Pace4	-1.50	1.04	.95	-4.39	1.39
		Control	1.91	1.04	.44	-.97	4.81
	Pace2	Pace1	3.16*	1.04	.02	.27	6.06
		Pace4	1.66	1.04	.71	-1.22	4.56
		Control	5.08*	1.04	.00	2.18	7.97
	Pace4	Pace1	1.50	1.04	.95	-1.39	4.39
		Pace2	-1.66	1.04	.71	-4.56	1.22
		Control	3.41*	1.04	.01	.52	6.31
	Control	Pace1	-1.91	1.04	.44	-4.81	.97
		Pace2	-5.08*	1.04	.00	-7.97	-2.18
		Pace4	-3.41*	1.04	.01	-6.31	-.52

Above table 10 indicates that the significant difference exist between pace 2 and control group, as p-value is 0.00 which is less than 0.05 (adjusted α level 0.0073). No significant difference found between any combinations.



In figure 1: Graphical representation of different pace with time intervals of muscular endurance.

Discussion

The objective of the study were to determine the main effect of time (with in groups), the main effect of paces (between groups) and interaction effect (time x pace) on muscular endurance due to practices of Suryanamaskar. The finding of the study revealed that there is a significant improvement found on muscular endurance in all experimental groups due to time (training duration) effect, between pretest and after 3 weeks, between pretest and after 6 weeks and between 3 weeks and after 6 weeks. There is no significant difference among gropes over all on their muscular endurance due to suryanamaskar training. Finding also shows that there is a significant interaction effect between groups and time. To know in detail about how muscular endurance improved in each of the training groups through the training program, one way repeated measures AVOVA was employed separately for each training groups (pace 1, pace 2, pace 4 and control group) and to know if there is a difference between training groups in each of the data readings, one way ANOVA was computed separately for all the three data readings (pretest, after 3 weeks and after 6 weeks). Interaction result shows that there is significant improvement found on muscular endurance in pace 2 group as the p- value (0.00) is less than 0.0073 (adjusted α level). Basically the key method for improved in muscular endurance is low resistance and high repetition (Miller, David 2006). Same way during practice of Suryanamaskar, body act as low resistance and numbers of round act as repetition, which might be the cause to improve the arm and shoulder girdle endurance. Particularly in step 4 and 9 (Ashwa sanchalanasana), 5 and 8 (Parvatasana), 6 (Ashtanga namaskara) and step 7 (Bhujangasana). In this

way present study confirmed that practice of Suryanamaskar for six weeks are sufficient to bring out significant improvement on muscular endurance with pace 1, pace 2 and pace 4. It also concluded that Suryanamaskar practice for 6 weeks with pace 2 help to improve maximum muscular endurance as compare pace 1, pace 4 and control group.

References:

- Saraswati, Swami S. (2009). Surya Namaskara A Technique of Solar Vitalization. Yoga Publication Trust: Munger Bihar, 1.
- Saraswati, Swami S. (2002). Asana Pranayama Mudra Bandha. Yoga Publication Trust: Munger Bihar, 159-172.
- Choudhary, R and Krzytof, Stec.(2010). "The Effect of Dynamic Suryanamaskar on Flexibility of University Students", J.A.D.Research. 1(1): 45-48.
- Miller, David K. (2006). Measurement by the Physical Educator Why and How, Mc Graw hill: New York, 159.
- Shankar, G and Pancholi, B. (2011). "The Effect of Suryanamaskar Yoga Practice on the Heart Rate, Blood Pressure, Flexibility and Upper Body Muscle Endurance in Healthy Adult", International Journal of Health Sciences & Research. 1(1): 2-6.
- Bhavanani, B. Kaviraja Udupa, K. and Ravindra, N. (2011). "A Comparative Study of Slow and Fast Suryanamaskar on Physiological Function". Ijoy International Journal of Yoga. 4(2): 71-76.
- Raja, S.Chidambara. (2012). "Effect of Yogic Practices on Flexibility, Cholesterol and Blood Pressure", International Interdisciplinary Research Journal. 2(4): 221-225.
- Sinha, B. Ray, U. S. Pathak, A. and Selvamurthy, W. (2004). "Energy Cost and Cardiorespiratory Changes During the Practice of Surya Namaskar", Indian J Physiol Pharmacol. 48(2): 184-190.
- Shankar, G and Pancholi, B. (2011). "The Effect of Suryanamaskar Yoga Practice on the Heart Rate, Blood Pressure, Flexibility and Upper Body Muscle Endurance in Healthy Adult", International Journal of Health Sciences & Research. 1(1): 2-6.
- Pratima, M. Bhutkar, Milind, V. Bhutkar, Govind, B.Taware, Vinayak, Doijad and Doddamani, B.R. (2008). "Effect of Suryanamaskar Practice on Cardio-Respiratory Fitness Parameters: A Pilot Study". Al Ame En J Med Sci. 1(2):126 - 129.
- Kumar, Sasi. Sivapriya, D.V and Thirumeni, S. (2011). "Effects of Suryanamaskar On Cardio Vascular And Respiratory Parameters In School Students", Recent Research In Science and Technology, 3(10):19-24.
- Gore, M. M. (2012). Anatomy and Physiology of Yogic Practices. New age books: New Delhi, xv.
