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EFFECT OF ASANAS ON MUSCLE STRENGTH - A VOLUNTEER BASED STUDY

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ABSTRACT
Yoga Sutra defines Asana as the stable and comfortable posture.[1] It brings about strength, lightness and health.[1] It is a dynamic position, in which the practitioner is perfectly poised between activity and non-activity, being doing and "being done by" the posture. Scientific studies on yoga demonstrate that yoga improves dexterity, strength and musculoskeletal coordination of the practitioners. Muscular strength is the ability of a muscle or muscles group to exert force to overcome the most resistance in one effort. Strength can be measured based on the amount of weight lifted. A healthy volunteer based study was conducted to know the effect of Asanas on the muscle strength. 60 volunteers were registered, and they were randomly allocated into two groups 30 volunteers each. Further, the volunteers were advocated to practice a set of selected Asanas for the period of 4 months. The assessment of muscle strength was done by means of hand grip dynamometer and Student self evaluation scale in the both groups before intervention, followed by the recording of observations at an interval of 1 month and 3 months respectively and after the period of 4 months,significant increase in the muscle strength was observed in the intervention group.

KEYWORDS- Yoga, Muscle strength, Asana, Blood Pressure.

INTRODUCTION
The strength is one of the most important factor in life to perform different kinds of activities and also required for the prevention of diseases. The strength enhances by the regular coordinated, systematic movements of muscles of all parts of the body in the form of exercise daily. The scientific evidences show that yogic exercise stimulates the process of growth and development. Physical inactivity is considerably more dangerous than physical activity. Individuals who are not physically active and who do not exercise their bones show decrease bone mineral content (or) low calcium in the skeleton, which may develop into osteoporosis. This condition increases the risk of fractures. Inactivity accelerates the process of ageing. Yogic exercise builds and maintains muscle strength, maintains gait function, prevents deformity, stimulates circulation, develops endurance and promotes relaxation and restores motivation and the well-being of the patient. Yogic practices have an added advantage of balancing the mind along with the physical strengthening due to the coordinated breathing along with the slow and steady movements of different groups of muscles involved in different Asanas. Hence, this volunteer based study was conducted to rebut the effect of Yogic practices on strengthening the muscles.

Primary Objective: To study the effect of Asanas on the strength of muscles.

Secondary Objective: To observe any change with respect to BMI.

MATERIAL AND METHODS
Present study was conducted in the Department of Sharir Rachana, Faculty of Ayurveda, IMS, BHU, Varanasi, India. The approval was obtained from DRC of the department of Rachana Sharir and Institutional Ethical committee before the commencement of the study.60 healthy volunteers (BAMS students) were registered from the Department of Rachana Sharira, IMS, BHU, and the subjects were randomly allocated into two groups, consisting of 30 subjects each

1. Group -B1 (Control)
2. Group -B2 (Yogasana)

The intervention group was advised to practice a set of selected Asanas enlisted below for a period of 4 months.

1. Hastotthanasana
2. Trikonasana
3. Utthanapadasana
4. Pavanamuktasana
5. Bhujangasana
6. Shavasana

Inclusion criteria

1. Healthy volunteers between age group 17-30 years.
2. Volunteers who agree to participate in research study.

Exclusion criteria

1. Healthy volunteers of age group >30 years or <17 years.
2. Volunteers who don't agree to participate in research study.

Assessment Criteria

Tools and techniques

Handgrip Dynamometer- Handgrip Strength Test- Hand grip strength can be quantified by measuring the amount of static force that the hand can squeeze around a dynamometer. The force has most commonly been measured in kilograms and pounds, but also in millilitres of mercury and in Newtons.

Student Self Evaluation Scale- This scale can be used to evaluate student's progress in all the Classical Yoga Postures. By keeping an accurate record of their practice, they can more readily determine their progress in making changes to their health and stamina.

The data collected were tabulated and analysed using statistical software SPSS version 16.0. The intragroup comparison was done to see the effect of treatment using Friedman's test for subjective parameters and paired t-test for objective parameters. The intergroup comparison between different groups for subjective parameters were done by Pearson's Chi-square test and objective parameters done by unpaired t test.

OBSERVATION AND RESULTS

Table no. 1: The distribution according to Age.

Age in years	Number and % of group		Total
	control	intervention	
17-23	22 (73.3%)	22 (73.3%)	44 (73.3%)
24-30	8 (26.7%)	8 (26.7%)	16 (26.7%)
Total	30 (100.0%)	30 (100.0%)	60 (100.0%)
χ^2 =0.000 p =1.000			

Table no. 2: Distribution according to Height.

Height	Number and % of group		Total
	control	intervention	
4.5-4.9 ft	2 (6.7%)	3 (10.0%)	5 (8.3%)
5.0-5.4 ft	18 (60.0%)	13 (43.3%)	31 (51.7%)
5.5 ft and above	10(33.3%)	14 (46.7%)	24 (40.0%)
Total	30 (100.0%)	30 (100.0%)	60 (100.0%)
χ^2 =1.673 p =0.433			

Table no. 3: The distribution according to Weight.

Weight	Number and % of group		Total
	volunteer control	volunteer intervention	
30-40 kg	1 (3.3%)	1 (3.3%)	2 (3.3%)
40-50 kg	11 (36.7%)	9 (30.0%)	20 (33.3%)
50-60 kg	10 (33.3%)	12 (40.0%)	22 (36.7%)
60-70 kg	5 (16.7%)	5 (16.7%)	10 (16.7%)
70-80 kg	3 (10.0%)	3 (10.0%)	6 (10.0%)
Total	30 (100.0%)	30 (100.0%)	60 (100.0%)
χ^2 =0.382 p =0.984			

Table no 4: Showing the effect with respect to Pulse rate.

Group	Pulse rate Mean and ± SD			Within the group comparison Paired t-test
	BT	F1	F2	BT-F2
Control	77.30± 9.93	76.47± 8.51	75.53± 6.64	1.77±3.87, t=2.49 p=0.018
Intervention	83.83± 10.51	80.47± 8.05	75.80± 4.44	-8.03±6.93, t=6.34 p=0.000
Between group comparison Unpaired t-test	t= -2.474 p=0.016	t= -1.871 p=0.066	t= -0.183 p=0.855	

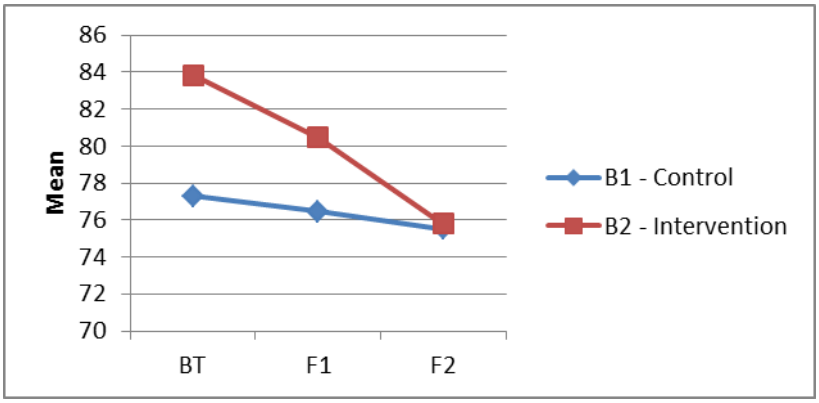


Table no. 5: Showing the effect with respect to Systolic blood pressure.

Group	Systolic blood pressure Mean and ± SD			Within the group comparison Paired t-test
	BT	F1	F2	BT-F2
Control	121.40± 8.96	121.20±6.51	121.00± 5.29	0.40±4.47, t=0.49 p=0.628
Intervention	121.67± 13.87	121.53±9.38	121.20±4.02	0.47±10.75, t=0.24 p=0.814
Between group comparison Unpaired t-test	t= -0.088 p=0.930	t= -0.160 p=0.873	t= -0.165 p=0.870	

Table no. 6: Showing the effect with respect to Diastolic blood pressure.

Group	Diastolic blood pressure Mean and ± SD			Within the group comparison Paired t-test
	BT	F1	F2	BT-F2
Control	74.33± 10.98	75.13± 9.40	76.07± 7.74	-1.73±3.85, t=-2.46 p=0.020
Intervention	74.53± 10.79	76.40± 7.56	78.93± 3.31	-4.40±8.72, t=-2.76 p=0.010
Between group comparison Unpaired t-test	t= -0.071 p=0.944	t= -0.575 p=0.568	t= -1.864 p=0.067	

Table no. 7: Showing the effect with respect to Respiratory rate.

Group	Respiratory rate Mean and ± SD			Within the group comparison Paired t-test
	BT	F1	F2	BT-F2
Control	20.87 ± 3.04	20.37±2.63	18.93± 1.84	1.93±1.96, t=5.39 p=0.000
Intervention	19.53± 3.91	8.53±2.42	17.40± 0.89	2.13±3.70t=3.16 p=0.004
Between group comparison Unpaired t-test	t= 1.471 p=0.147	t= 2.810 p=0.007	t= 4.110 p=0.000	

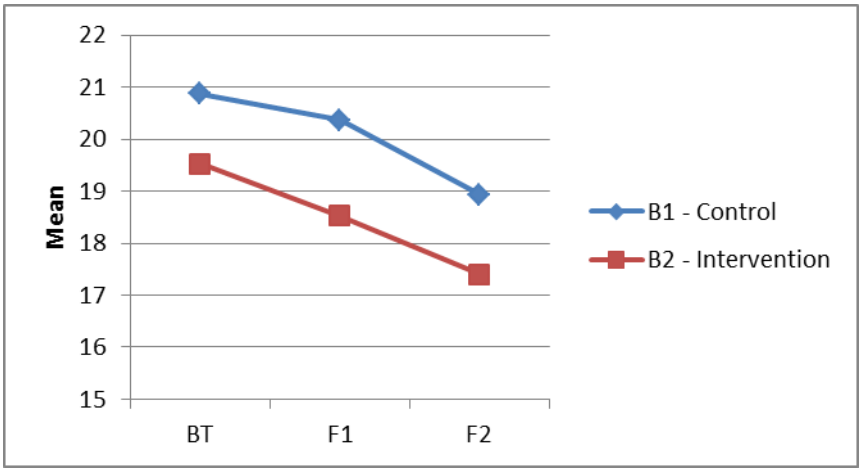
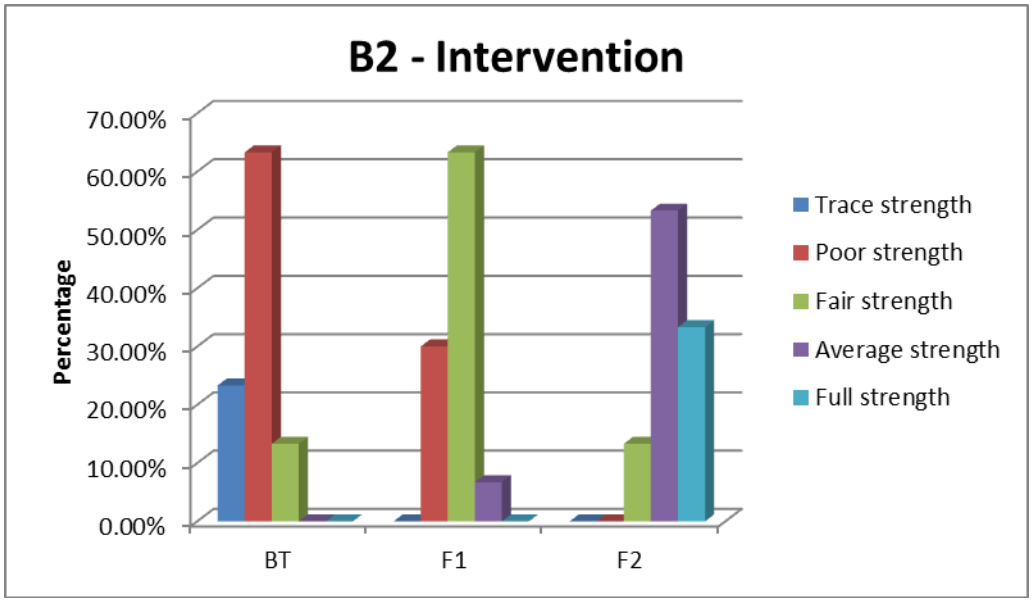


Table no. 8: The effect with respect to Student Self- Evaluation Scale.

Group	Grade	Student Self Evaluation Scale Number and % of cases			Within the group comparison Friedman test
		BT	F1	F2	
B1- Control	Trace strength	4 (13.3%)	3 (10.0%)	1(3.3%)	χ^2=17.333 p=0.000
	Poor strength	16(53.3%)	16(53.3%)	8 (26.7%)	
	Fair strength	9 (30.0%)	8 (26.7%)	18(60.0%)	
	Average strength	1 (3.3%)	3 (10.0%)	3(10.0%)	
	Full strength	0 (0.0%)	0 (0.0%)	0(0.0%)	
B2-Asana	Trace strength	7 (23.3%)	0(0.0%)	0(0.0%)	χ^2=58.207 p=0.000
	Poor strength	19(63.3%)	9 (30.0%)	0(0.0%)	
	Fair strength	4(13.3%)	19(63.3%)	4(13.3%)	
	Average strength	0(0.0%)	2 (6.7%)	16(53.3%)	
	Full strength	0 (0.0%)	0 (0.0%)	10(33.3%)	
Between group comparison Chi- square		χ^2=3.998 p=0.262	χ^2=9.641 p=0.022	χ^2=36.804 p=0.000	



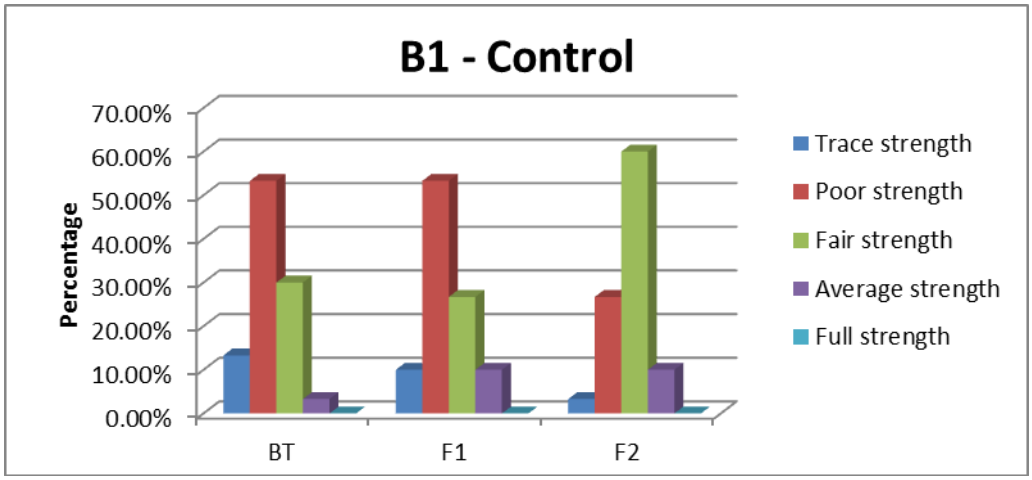


Table no. 9: The effect on Isometric strength of right hand.

Group	Isometric strength of right hand Mean and ± SD			Intra-group comparison Paired t-test
	BT	**F1**	**F2**	BT-F2
B1-Control	27.20± 15.19	28.30± 15.35	29.53± 15.54	-2.33±1.09,t=-11.68 p=0.000
B2-Asana	33.90± 21.63	40.53± 22.93	53.87±24.97	-19.97±6.27,t=-17.45 p=0.000
Inter-group comparison Unpaired t-test	t= -1.388 p=0.170	t= -2.428 p=0.018	t= -4.531 p=0.000	

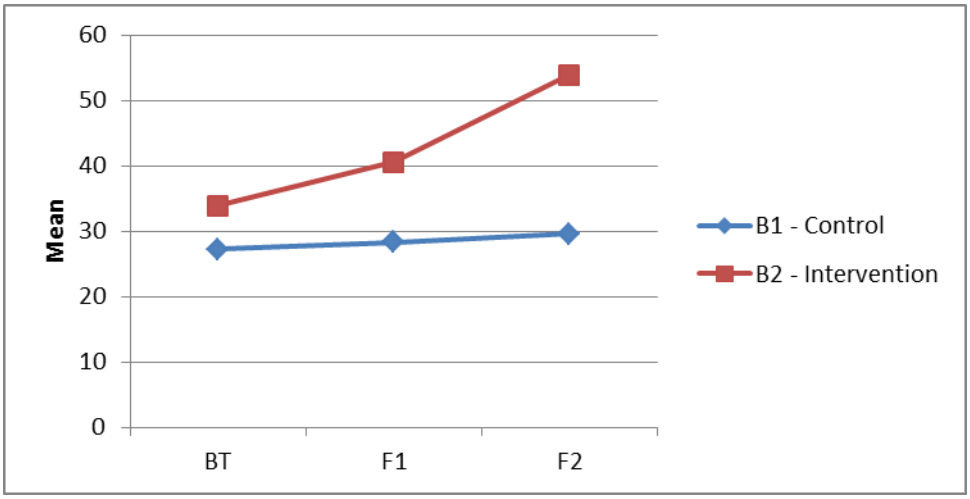
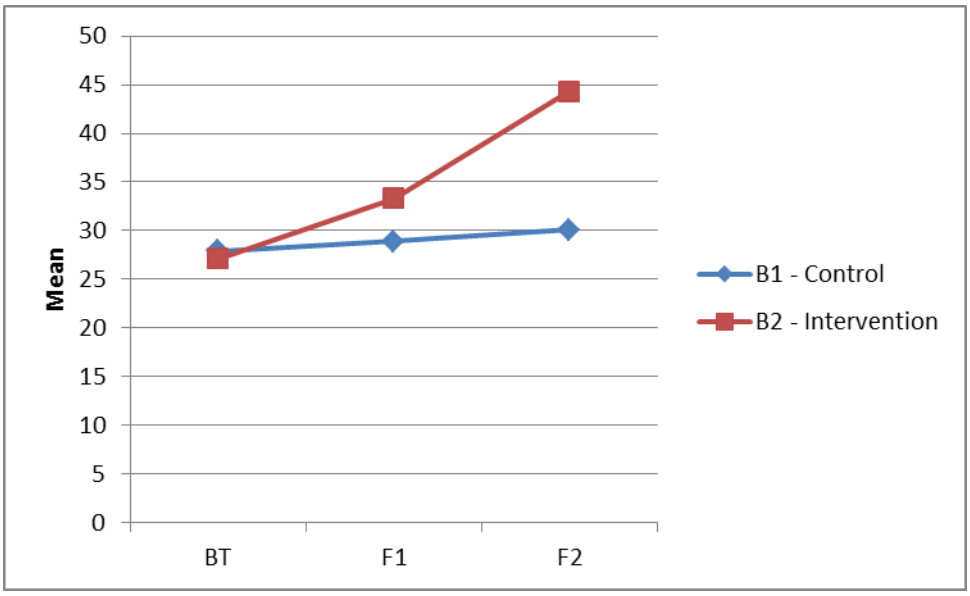


Table no. 10: The effect onIsometric strength of left hand.

Group	Isometric strength of left hand Mean and ± SD			Intra-groupcomparison Paired t-test
	BT	F1	F2	BT-F2
B1-Control	27.90±18.37	28.87±18.04	30.07± 18.19	-2.17 ± 1.55 t=-7.62, p=0.000
B2-Asana	27.10±19.50	33.30±20.03	44.33±20.80	-17.23 ± 5.76 t=-16.39, p=0.000
Inter-group comparison Unpaired t-test	t= 0.164 p=0.871	t= -0.901 p=0.371	t= -2.828 p=0.006	



DISCUSSION

The observation table no. 4 depicts that the Mean ±SD of the Pulse Rate in healthy volunteer intervention group. The decrease in pulse rate is seen with each follow up, which is statistically significant ($p<0.001$). In inter group comparison test difference was statistically significant ($p<0.05$) initially which becomes insignificant ($p>0.05$) at the 2nd follow up.

The results observed in present study is similar to the study conducted by Kewal Krishan and Sudhir Kumar Sharma (2009), on "Effects of Yogic Practices and Callisthenic Exercises on Resting Pulse Rate Variable of Secondary School Boys", show that after six weeks of the training theresting pulse rate of yogic practices group was better than the other two groups.

The observation table no.5 depicts that the Mean ±SD of the Systolic blood pressure in healthy volunteer

intervention group. The decrease in Blood pressure was observed with each follow up, which is statistically insignificant (p>0.05). In inter group comparison difference in healthy subgroup remain insignificant (p > 0.05), which was insignificant before treatment (p >0.05). This shows better effects of intervention in comparison to control group.

This result is in line with the findings of George A. Kelley and Kristi Sharpe Kelle (2000) that there was a significant reduction in blood pressure after the resistance training. Madanmohan et al.(2004) has found that the practices of yoga have reduced the blood pressure significantly. Khanam A.A. et al(1996) findings showed that the yoga in long duration affects hypothalamus and brings about decrease in the systolic blood pressure. The findings of Muralidhara and Ranganathan (1982) revealed that hatha yoga can lower the blood pressure. The observation table no.6 depicts that in inter group comparison in demonstrates that interventions show better results in lowering down systolic BP in healthy group with statistically significant (p<0.001) difference. Talukdar B, Verma S, Jain S. C. and Majumdar M. (1996), had done a research on "Effect of *Yoga* Training on Plasma Lipid Profile, R.B.C. Membrane Lipid Peroxidation and Na+K + ATPase Activity in Patients of Essential Hypertension". It was found that hypertensive subjects had an elevated lipid peroxidation and decreased Na+K + ATPase activity in plasma membrane as compared to normotensive healthy controls, the specific *yoga* training protocol which was administered not only helped to decrease blood pressure but also retard the progression of cellular damage due to free radicals, which is coherent to present study.

Observation table no. 7 depicts that the Mean ±SD of the Respiratory Rate in healthy-intervention, decrease with each follow up, which is statistically significant (p<0.05) While in healthy-control sub group. In inter group comparison test difference was statistically significant (p<0.001) after 2nd follow-up, which was initially insignificant. This shows better effects of intervention in comparison to control group. This result is similar to the study conducted by **Madanmohan et al.(2008)** to designed to test whether *yoga* training of six weeks duration modulates sweating response to dynamic exercise and improves respiratory pressures, handgrip strength and handgrip endurance.

The observational table no. 8-10 clearly depicts that the Muscle strength in control and intervention group increases with each follow up. Initially there was no significant difference of muscle strength among Control and Asana groups (p>0.05). The intra group comparison of Muscle strength was found statistically highly significant (0.0%) after a period of 4 months in both the groups. The inter group comparison of Muscle strength was found statistically highly significant (p<0.05) at the end of 2nd follow up. The increase in the Muscle strength was more pronounced in the intervention group in comparison to the control group.

According to Raub J. A. (2002) the three main elements used in hatha yoga to attain its purposes are the body, the physical part of man; the mind, the subtle part; and the element that relates the body with the mind in a special way, the breath. Over the last 10 years, a growing number of research studies have shown that the practice of hatha yoga can improve strength, strength endurance and flexibility, and may help control such physiological variables as blood pressure, respiration and heart rate, cardiovascular endurance and maximum oxygen consumption to improve overall exercise capacity.[1] The findings of Arciero et al. (2009) has found that the yoga and functional resistance training has improved the cardiovascular endurance.[2] The position of the asana causes a squeezing action on a specific organ or gland, resulting in the stimulation of that part of the body. This leads to an enhancement in blood supply to the muscles and ligaments resulting in relaxing of muscles and ligaments. Further it releases the pressure over nerves in that area.[3] The stretching is involved in all the Asanas, hence it has such a beneficial effect on the body. During maintenance of the yoga posture the breathing is slow and deep, with theabdominal movement i.e. abdominal or slow respiration.[4] This increases the oxygen supply and probably enhances the flow of Prana to the target organ or gland, thereby enhancing the strength. Improvement in the blood circulation leads to enhanced oxygen supply resulting in enhanced energy supply to the particular muscle producing significant improvement in strength, endurance, flexibility of muscles along with increased cardiovascular endurance. Some of the relaxing Asanas like Shavasana, vajrasana and yogamudra may have the reason of significant decrease in the in blood pressure and resting pulse rate.[5]

The study of Kwon HR et al. (2010) showed that the low intensity resistance training as like yogic exercise was effective in increasing muscle mass and strength.[6] Moreover, the findings of Jauregui-Ulloa et al. (2007) showed that the yoga practice improves the muscular strength.[7] The findings of Madanmohan et al. (2008) showed that the yoga training for a short period of 6 weeks can produce significant increase in muscle strength[8] and the studies of Hagins M. et al. (2007) showed that yoga practices improve strength of upper and lower extremities. Hagins M. et al. (2007) found that yoga practices improve strength of upper and lower extremities, which are also in line with the findings of the present study.[9]

The observation table no.9 and 10 depict that the Mean ±SD of the Isometric strength of right hand and left hand in healthy-intervention, increase with each follow up, which is statistically significant. Initially there was no significant difference of Isometric muscle strength among Control and Asana groups (p>0.05). In inter

group comparison test difference was statistically significant ($p<0.001$) after 2nd follow-up.

The results found in the present study was similar to study by Madanmohan et al. (2008) designed to test the effect of six weeks yoga training on sweating response to dynamic exercise. The study showed an improvement in respiratory pressures, handgrip strength and handgrip endurance.

A very early description by Wada in 1922, attempted to establish a relationship between basic rhythms (i.e., hunt-eat-rest) and hand grip strength (Shannahoff-Khalsa, 1991; Shannahoff-Khalsa, 2008).[10]

CONCLUSION

The Yogasanas enhance the muscle strength and Student self–evaluation scale for assessment of muscle strength in the healthy volunteers. Hence these Asanas can be used among sports personnel and other fields requiring muscular strength for enhancing their performance.

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