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The Effect of Suryanamaskar on Static and Dynamic Balance in Young Overweight and Obese Individuals

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Abstract: ***Study design:*** *experimental study* ***Background:*** *There have been studies in the past demonstrating significant cardio-respiratory, musculoskeletal and metabolic health benefits of Suryanamaskar. The need of the hour has favored us answer this research question regarding the efficiency of Suryanamaskar in improving the core strength and thus the postural control assessed by static and dynamic balance in overweight and obese individuals.* ***Method:*** *A total of 62 subjects participated in the study (30-Control & 32-Experiment group). Outcome measures studied were deep abdominal muscle thickness using ultrasonographic imaging; static balance measured by unilateral stance using Neurocom Balance Master™ and dynamic balance using Star Excursion Balance Test.* ***Results:*** *paired & unpaired t-test was used to analyze their performance.* ***Conclusion:*** *6-weeks of Suryanamaskar enhanced the thickness of the deep abdominal muscles as seen by ultrasound imaging; static balance as measured by Unilateral Stance Test & Limits of Stability and dynamic balance as measured by the Star Excursion Balance Test.*

Keywords: Yoga, Suryanamaskar, Obesity, Core strength, Balance

1. Introduction

Balance or postural control is imperative to activities of daily living. It is the ability to maintain the body's centre of gravity within the limits of stability as determined by base of support[1]. It can be described as either static or dynamic. Static balance can be defined as the ability to maintain a base of support while minimizing movement of body segments and centre of mass[1]. Dynamic balance involves the completion of a functional task without compromising an established base of support[2,3]. Dynamic control is important in many functional tasks as it requires integration of appropriate levels of proprioception, range of motion and strength[1]. Fjeldstad et al have reported that obese subjects have a higher prevalence of falls and ambulatory stumbling or a loss of balance than their non-obese counterparts. Since balance is such an important aspect of everyday life, it is imperative to find programs useful for maintaining and/or improving proper balance[1]. Postural control is essential to movement in a multiplanar fashion. Clark et al proposed that all functional activities are triplanar and require acceleration, deceleration and stability[4]. The core plays an integral role in multiplanar movement and postural control. Core muscles, are activated prior to the gross body movements[4,5]. Postural muscles, including transversus abdominis, internal and external oblique muscles, provide trunk stability, which is crucial to balance (Mulhearn and George, 1999)[6]. Some of the Fitness Programs that follow core-strengthening principles are Pilates, Yoga (some forms), Tai Chi, Feldenkrais, Somatics, Matrix dumb-bell program[7]. Suryanamaskar consists of a sequence of 12 yoga postures, each posture counteracting the preceding one producing a balance between flexion and extension, performed with synchronized breathing and aerobic activity[8, 9]. Suryanamaskar stimulates every large muscle group in the body. It stretches up to 97% of the body muscles and improves the general physical fitness by strengthening the muscles[9, 10]. Chaturanga Dandasana, yoga plank or push up, which is one of the 12 postures of suryanamaskar, is excellent for core control[11]. There are a few studies demonstrating significant cardio-respiratory, musculoskeletal and metabolic health benefits of Suryanamaskar[8, 9], but there has been no study demonstrating the effect of Suryanamaskar on core strength. We wish to study aims the effect of Suryanamaskar on core strength and thus on postural control assessed by static and dynamic balance in overweight and obese individuals.

2. Materials and Methods

A total of 62 subjects (32 in experimental & 30 in control group) in the age group of 18 to 25 years, with body mass index (BMI) more than 23kg /m^2, who had not been involved in any form of core strengthening or formalized Yoga training program earlier, were enrolled. Demographic data regarding age, gender, height, weight and BMI were recorded for all study participants. Baseline measures for deep abdominal muscle thickness using Ultrasound Imaging; Unilateral Stance Test using Neurocom™ Balance Master and Star Excursion Balance Test were also recorded as per the standard procedure. The experimental group was divided into 3 smaller groups of 10 subjects each to assure proper supervision and correct performance of the Suryanamaskar. We started with one week of preparatory practices for Suryanamaskar, followed by 5 weeks of Suryanamaskar. All the participants completed 30 sessions of Suryanamaskar within a 6-week period.

The experimental and control group were given an awareness on healthy lifestyle and eating habits; and were

allowed to continue their daily activities during this time period.

Ethical approval: The study was approved by the Ethics & Research Committee at Pad. Dr. D. Y. Patil University. All subject identification information that was collected during research has been kept strictly confidential.

Data Analysis. Data was collected on a data sheet & encoded for computerized analysis using SPSS 16. Tables were made using Microsoft Word and figures were plotted using Microsoft Excel 2007. Statistical analysis of the two group reveal a p value>0.05(insignificant) showing that the two groups are homogeneous with respect to age, height, weight and BMI.

3. Descriptive Analysis

Table 1(a): Comparison of external oblique muscle thickness over a period of 6 weeks in experimental group

External oblique muscle	PRE			POST			
	Mean	SD	Std Error	Mean	SD	Std Error	P Value
Relaxed	0.4353	0.1118	0.0198	0.4687	0.0969	0.0171	0.090
Contracted	0.4584	0.0910	0.1609	0.5450	0.0879	0.0155	0

*p value < 0.05 is significant.
Inference: There was an improvement in external oblique thickness at the end on 6 weeks

Table 1 (b): Comparison of internal oblique muscle thickness over a period of 6 weeks in experimental group

Internal Oblique Muscle	*Pre*			*Post*			
	Mean	*SD*	*Std Error*	*Mean*	*SD*	*Std Error*	*P Value*
Relaxed	0.5445	0.1025	0.0181	0.5961	0.1165	0.0206	0.009
Contracted	0.6391	0.1236	0.0219	0.7319	0.1446	0.0255	0

*p value < 0.05 is significant.
Inference: There was an improvement in internal oblique thickness at the end on 6 weeks

Table 1(c): Comparison of transversus abdominis muscle thickness over a period of 6 weeks in experimental group

Transversus abdominis muscle	*Pre*			*Post*			
	Mean	*SD*	*Std Error*	*Mean*	*SD*	*Std Error*	*P Value*
Relaxed	0.2808	0.0670	0.0118	0.3159	0.0687	0.0121	0.008
Contracted	0.4305	0.1091	0.0193	0.500	0.1019	0.0180	0

*p value < 0.05 is significant.
Inference: There was an improvement in transversus abdominis thickness at the end on 6 weeks

Table 2: Comparison of sway velocity using unilateral stance test over a period of 6 weeks in experimental group

Unilateral stance test	*PRE*			*POST*			
	Mean	*SD*	*Std Error*	*Mean*	*SD*	*Std Error*	*P Value*
Eyes open	1.2766	0.18003	1.01838	1.8312	0.54755	3.09742	0.334
Eyes closed	7.2734	0.72851	4.12107	4.6625	0.58577	3.31363	0

*p value < 0.05 is significant.
Inference: there was a reduction (improvement) in the sway velocity with eyes closed at the end of 6 weeks

Table 3: Comparison of reach distance using star excursion balance test over a period of 6 weeks in experimental group

SEBT	*PRE*			*POST*			
	Mean	*SD*	*Std Error*	*Mean*	*SD*	*Std Error*	*P Value*
Anterior	68.031	4.9342	0.8722	78.080	8.8392	1.5626	0
Antero-medial	71.274	5.1207	0.9052	80.072	8.6317	1.5259	0
Medial	70.577	4.1800	0.7389	78.491	8.5465	1.5108	0
Postero-medial	66.496	5.2323	0.9250	74.374	9.6429	1.7046	0
Posterior	59.815	5.6444	0.9978	67.313	6.6279	1.1717	0
Postero-lateral	53.849	6.8161	1.205	62.229	7.6722	1.3563	0
Lateral	44.234	6.8838	1.2169	53.907	8.1412	1.4392	0
Antero-lateral	63.010	5.9671	1.048	72.192	7.0503	1.2463	0

*p value < 0.05 is significant.
Inference: There was an improvement in the reach distance in all directions, at the end of 6 weeks

Table 4 (a): Inter group comparison of external oblique muscle thickness over a period of 6 weeks

External Oblique	*Experimental*			*Control*			
	Mean	*SD*	*Std Error*	*Mean*	*SD*	*Std Error*	*P Value*
Relaxed	0.4687	0.0969	0.0171	0.4490	0.10319	0.01884	0.440
Contracted	0.5450	0.0879	0.0155	0.4708	0.10688	0.01951	0.004

*p value < 0.05 is significant.
Inference: The external oblique muscle thickness in the experimental group shows significant improvement in contracted state after 6 weeks compared to the control group.

Table 4 (b): Inter group comparison of internal oblique muscle thickness over a period of 6 weeks

Internal Oblique Muscle	*Experimental*			*Control*			
	Mean	*SD*	*Std Error*	*Mean*	*SD*	*Std Error*	*P Value*
Relaxed	0.5961	0.1165	0.0206	0.6000	0.11282	0.02060	0.894
Contracted	0.7319	0.1446	0.0255	0.6757	0.12433	0.02270	0.104

*p value < 0.05 is significant.
Inference: The internal oblique muscle thickness in the experimental group does not show significant improvement in relaxed and contracted state after 6 weeks compared to the control group.

Table 4 (c): Inter group comparison of transversus abdominis muscle thickness over a period of 6 weeks

Transversus Abdominis Muscle	*Experimental*			*Control*			
	Mean	*SD*	*Std Error*	*Mean*	*SD*	*Std Error*	*P Value*
Relaxed	0.3159	0.0687	0.0121	0.3383	0.08309	0.01517	0.251
Contracted	0.500	0.1019	0.0180	0.4843	0.12146	0.02218	0.580

*p value < 0.05 is significant.

Inference: The Transversus abdominis muscle thickness in the experimental group does not show significant improvement in contracted and relaxed state after 6 weeks compared to the control group.

Table 5: Inter group comparison of sway velocity using unilateral stance test over a period of 6 weeks

Unilateral Stance Test	*Experimental*			*Control*			
	Mean	*SD*	*Std Error*	*Mean*	*SD*	*Std Error*	*P Value*
Eyes open	1.8312	0.54755	3.09742	4.4683	.65036	3.56217	0.003
Eyes closed	4.6625	0.58577	3.31363	9.9867	.39767	2.17810	0

*p value < 0.05 is significant.
Inference: The Sway Velocity in the experimental group shows significant improvement after 6 weeks compared to the control group.

Table 6: Inter group comparison of reach distance using star excursion balance test over a period of 6 weeks

Sebt	*Experimental*			*Control*			
	Mean	*SD*	*Std Error*	*Mean*	*SD*	*Std Error*	*P Value*
Anterior	78.080	8.8392	1.5626	61.300	5.6303	1.0279	0
Antero-medial	80.072	8.6317	1.5259	62.000	5.7745	1.0543	0
Medial	78.491	8.5465	1.5108	61.083	3.8776	0.7080	0
Postero-medial	74.374	9.6429	1.7046	59.433	3.7479	0.6843	0
Posterior#	67.313	6.6279	1.1717	58.267	4.9020	0.8950	0.209
Postero-lateral	62.229	7.6722	1.3563	55.817	5.1335	0.9373	0
Lateral	53.907	8.1412	1.4392	51.583	6.0302	1.1010	0
Antero-lateral	72.192	7.0503	1.2463	59.033	5.4850	1.0014	0

*p value < 0.05 is significant.
Inference: The reach distance shows a significant improvement in all directions except posterior, in the experimental group compared to the control after 6 weeks.

4. Discussion

We had hypothesized that suryanamaskar is an effective means of strengthening the deep abdominal muscles thus leading to improved static and dynamic balance. The statistical analysis confirmed our hypothesis wherein on comparing the thickness of the deep abdominal muscles and the static & dynamic balance in experimental versus control group; we found that the experimental group showed significant improvement in the thickness of the muscles, static and dynamic balance post intervention as compared to the control group. Attendance and adherence to practice is a very important factor that influences the effectiveness of the Suryanamaskar, a yoga based exercise. In our study, participants attended nearly all of the exercise sessions. This might particularly account for the positive effects of the 6-week intervention.
The deep abdominal muscle thickness measured using Ultrasound Imaging showed a significant improvement the end of 6 weeks of suryanamaskar. External oblique (EO) in contracted state (p=0), internal oblique (IO) in relaxed and contracted state (p=0.009), transversus abdominis (TrA) in relaxed and contracted state (p=0.008 & p=0). This is in agreement to findings of C.M. Norris[12], who ascertained the role of external oblique, internal oblique and transversus abdominis as stabilizers of trunk during movement. The reason for the improvement in the core strength could be that, Suryanamaskar is a compilation of 12 yoga postures each posture counteracting the preceding one producing a balance between flexion and extension. The plank (5th posture) and the downward facing dog (8th posture) pose, in particular, are shown to improve the core strength[13]. Moreover, during the back extension postures, the anterior truck muscles are stretched leading to better contraction in the proceeding posture (Frank-Starling's Law).

The static balance as measured with the Unilateral Stance Test on *Neurocom* Balance Master™, with eyes closed, showed significant improvement (p=0) statistically with mean sway velocity value improving from 7.27 to 4.66 degree/sec, after 6-weeks. The control group shows significant deterioration or increase in the sway velocity with eyes open and closed (p=0.001 for both) after 6-weeks. The stabilization of the trunk is crucial for maintaining balance. Since suryanamaskar training improved trunk stabilization by improving the core strength, it thereby aided in improved static balance too. Training approaches that improve neuromuscular coordination, joint strength and ROM are also likely mechanisms that lead to improved balance[14]. Suryanamaskar is performed by synchronized breathing which helps to improve neuromuscular co-ordination[9, 15]. It is also known to enhance the strength muscles, flexibility, joint strength and leads to optimum muscle recruitment thereby boosting balance[10]. The reason for the deterioration in the sway velocity could be the statistically significant increase in weight (p=0.013) in the control group after 6-weeks. Oliver Hue et al (2006) concluded that a decrease in balance stability is strongly correlated to an increase in body weight[16].

The goal of the SEBT is to force subjects to disturb their equilibrium to a near maximum and then return back to a state of equilibrium[4].The SEBT shows a significant improvement in all 8 directions (p=0 in all directions) after 6 weeks of suryanamaskar. The control group did not show a significant difference in SEBT readings after 6 weeks, except for antero-medial direction. In accordance with our findings, it was reported by Johnson et al (2007) that core strengthening exercise could improve dynamic balance in healthy adults.

Thus Suryanamaskar leads to an improvement in core strength which might percolate to an enhanced static and dynamic balance in the experimental group.

5. Conclusion

6-weeks of Suryanamaskar has significant improvement in the thickness of the deep abdominal muscles- external oblique, internal oblique and transversus abdominis as seen by ultrasound imaging. There has been significant improvement on static balance as measured by Unilateral Stance Test and on dynamic balance as measured by the Star Excursion Balance Test.

6. Clinical Implications

The core strength is important for the overall spinal health. It can be used as a preventive adjunct to people predisposed to

mechanical low back pains. In adjunct with a calorie restricted diet regime, it can be used for weight reduction in over-weight and obese individuals. It can be implemented for peri and post-menopausal females, to improve their core-strength and balance. It can be implemented as post natal exercise after 2 months of delivery and after abdominal surgeries to strengthen the core.

7. Study Limitations

The study could have been continued for a longer duration of time, to see statistical significant improvement in deep abdominal muscle thickness in the experimental group as compared to the control group. The subjects could be re-evaluated after some duration of time to see whether the improvement in thickness of the deep abdominals is maintained or not.

8. Scope for Future Studies

Further research can be carried out to investigate the effects of suryanamaskar on the diaphragm, pelvic floor muscles and the multifidis, which are also a part of the "core" muscles. Research can be carried out to re-assess the core strength and balance after a few months to see whether the improvement is maintained after a period of time.

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