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"Cognitive Effects of Suryanamaskar at Different Intensities in Adolescents": A Randomized Controlled Trial

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ABSTRACT

Lack of adequate physical inactivity is a growing global concern, as well as in India.Regular physical activity not only improves physical health but also enhances cognitive Fitness. Surya namaskar, a well known Indian form of aerobic exercise, has been shown on cognitive fitness. This study was carried out to evaluate intensity response alteration of suryanamaskar on cognitive functions in Adolscents .

Methodology:*A single blinded, randomised control trial was carried out among 136 children aged 12- 17 years. The children were selected using multistage cluster random sampling. A 12 weeks intervention was applied in 3 groups with variable intensity, viz, vigorous, moderate and mild intensity suryanamaskar. A fourth group did not underwent the intervention, and acted as a control group. The outcomes measures was Stroop test for cognitive function. The data was analyzed using SPSS v25 and paired t-test and ANOVA with post hoc Tukey's was applied for comparisons.*

Results:*It was observed that all 3 various intensity suryanamaskar groups showed significant Improvement in cognition at post-intervention measurement, whereas the control group did not show a significant improvement. On multiple comparisons, all 3 various intensity suryanamaskar group showed better improvements in the outcome measures compare to control group at the end of 12 weeks, but the vigorous intensity showed the largest improvement.*

Conclusion: *Vigorous intensity suryanamaskar for 12 weeks substantially improve cognitive function among adolscents*

Key Words: *Suryanakaskar, Adolscents , Physical Activity, Cognitive Function, Stroop test*

INTRODUCTION

Background

As defined by American Psychological association "Cognition includes all forms of knowing and awareness such as perceiving , conceiving remembering reasoning ,judging imagining and problem solving"

With the onset of COVID-19 pandemic along with the direct impact on the affected patients, the preventive measures like social distancing and home confinement has caused impact on the physical and mental health of the non-affected as well.

While adults are often accustomed to independent exercise, the majority of children receive their main exposure to exercise through school and recreational activities, as well as important social activities such as summer camps during school breaks. All of these activities were extremely restricted during the COVID-19 pandemic. In a Canadian study, it was found that only 4.8% of children are meeting the movement behaviours guidelines during the COVID-19 pandemic.(4) As estimated by the United Nations Educational, Scientific and Cultural Organization (UNESCO) on March 26, 2020, school closures have affected 87% of the world's students (i.e., more than 1.5 million children and young people in 165 countries) by restricting access to education.(5) School closure may also cause disruptions in the physical activity, social interaction and metal health of children. Fear of being infected is one risk factor for depressive symptoms in primary school students and anxiety symptoms in children and adolescents during the COVID19 pandemic.(6–9)

So the need of the hour is to introduce strategies to prevent the situation of adverse childhood experience (ACEs) which may hamper the cognitive, mental and physical health and working capacity of the future adults. Therapeutic Exercises seems to the BEST available solution for the problem.

Indian literature on ancient exercise science are available. More than one hundred and twenty slokes (aphorism) on exercise (vyayama) are discovered from Charaka Samhita. Suryanamaskar, is a practice of yoga as exercise incorporating a flow sequence of twelve gracefully linked asanas. With the requirement of minimum space and not gadgets, it can be an excellent aerobic exercise/physical activity option for children to develop their physical fitness. The benefits of a suryanamaskar practice are so many that for

example, in the late 1940's, Shrimant Bhavanrao Pant Pratinidhi (1868- 1951; Raja of Aundh 1909-1947) made suryanamaskar a compulsory part of the physical training program in his kingdom's schools. He helped to popularize suryanamaskar as a simple physical exercise for the all-round development of an individual.(14)

Suryanamaskar or Sunsalutation is an Indian form of aerobic exercise. It is sequence of poses that involves attainment of a series of yogic postures in succession, coordinating with breathing

The variability of MET intensities for Suryanamaskar (sun salutations), which ranged from 2.9 METs (light intensity) to 7.4 METs (vigorous intensity).(16–18) As ACSM guidelines classifies every aerobic exercise into mild, moderate and vigorous according to the intensity at which it is done. With the increasing popularity of Suryamanskar, it is important to understand the intensity of suryanamaskar within the context of the public health and exercise prescription guidelines recommended by the American College of Sports Medicine (ACSM). According to Bihar school of yoga, Surya namaskar style can be followed with variations in speed. The same count is followed for fast suryanamaskar, medium pace suryanamaskar and slow suryanamaskar practice that SN at different speeds provides different benefits.(19)

Need of the study

To summarize, cognitive fitness, which is a key component for academic achievement among adolescents, is positively affected by physical activity but often underestimated in the present fitness testing batteries. To attain the optimal level of cognitive fitness, the different intensities including mild, moderate and vigorous intensity of an aerobic exercise has to be defined. Surya namaskar, a well known Indian form of aerobic exercise, has been shown to improve flexibility, strength, cardiovascular health, and overall fitness, as well as cognitive fitness and mental clarity. It is culturally relevant and widely practiced in Indian continent. Additionally, Surya namaskar can be performed with various speeds. Thus, this study was planned based on hypothesis that Surya namaskar, performed at different speeds would have different effects on cognitive functions in adolscents .

Aim of the Study

To estimate the intensity response alteration of Suryanamaskar on cognition in adolescents at the end of 12 weeks.

Objectives of the study

1. To study the effect of mild intensity Suryanamaskar on Stroop test adolscents at the end of 12 weeks
2. To study the effect of moderate intensity suryanamaskar Suryanamaskar on Stroop test adolscents at the end of 12 weeks
3. To study the effect of Vigorous intensity suryanamaskar Suryanamaskar on Stroop test adolscents at the end of 12 weeks
4. To study the effect of School/ Junior College based Physical Education activities on suryanamaskar Suryanamaskar on Stroop test adolscents at the end of 12 weeks
5. To compare intensity response alteration of suryanamaskar on Suryanamaskar on Stroop test adolscents at the end of 12 weeks

Null hypothesis: There will be no difference in effect of Mild intensity, Moderate intensity, Vigorous intensity Suryanamaskar and School/ Junior College based Physical activity on Suryanamaskar on Stroop test adolscents at the end of 12 weeks

Hypothesis (H1): Mild intensity Suryanamaskar will be more effective than Moderate intensity, Vigorous intensity Suryanamaskar and regular physical Activity Suryanamaskar on Stroop test adolscents at the end of 12 weeks

Hypothesis(H2): Moderate intensity Suryanamaskar will be more effective than Mild intensity ,vigorous intensity Suryanamaskar and regular physical Activity Suryanamaskar on Stroop test adolscents at the end of 12 weeks

Hypothesis(H3:Vigorous Intensity Suryanamaskar will be more effective than Mild, moderate intensity Suryanamaskar and regular physical activity Suryanamaskar on Stroop test adolscents at the end of 12 weeks

Hypothesis(H4): School / Junior College based Physical activity will be more effective than of Mild intensity, Moderate intensity ,Vigorous intensity Suryanamaskar Suryanamaskar on Stroop test adolscents at the end of 12 weeks

METHODOLOGY

- **Study Design**: Single Blinded, Randomised Control trial
- **Study Setting:** Schools/ Junior Colleges in and around the City
- **Sample Size**: Total 136 Children. The sample size was calculated based on assumptions of an effect size 0.25, power 0.80.
- **Sampling Method:** Multistage Cluster Sampling: Simple random sampling
- **Method of Allocation**: Sealed envelope method
- **Duration of Intervention**: 12 weeks
- **Duration of Study**: 2 years
- **Inclusion Criteria:**
- 12 - 17 years of Children.
- BMI from 5th to 85th percentile (normal BMI range for age group 10-17 years)
- Children willing to participate
- **Exclusion Criteria:**
- Trained/athlete/hyperactive child.
- Children on medications for any diagnosed medical condition. Children having any previous episode of acute and/or chronic cardiorespiratory illness as reported by the parents or School/ Junior College authorities.
- Children with any neurological, cognitive disorders or hearing difficulties.
- Children having musculoskeletal disorders/deformities
- **Materials Used**.
- Pre and post Test Evaluation score-sheets
- Pen.
- Color Printed Card for Stroop Test
- Yoga Mats
- **Outcome Measures:**
  - Cognitive functions were assessed using Stroop Test

- **Study Procedure**
- Adolescent urban school/junior college children from 12 to 17 years of age were randomly selected for the study using multistage cluster sampling.
- The city was divided into four zones namely central, north, south and west. A list of SSC, CBSE board schools / Junior Colleges was drawn and one from each zone was chosen randomly. Thus, study was conducted in four different schools.
- Interaction with parents to obtain consent, and to explain the study was conducted during the Parents teacher meeting sessions held at respective schools/junior colleges
- Students of Standard 7th to 12th /junior colleges were included from each school, according to the age criteria
- The children were randomly selected according to their roll numbers. Every odd roll number was selected from the central and north zone and every even roll number was selected from the west and south zone.
- If the selected child was absent on the day of selection, he/she was skipped and the next odd/even roll number was selected accordingly.
- Consent was obtained from the participant's school teachers and an assent letter from the parents / guardians of the students for the study.
- The pre-intervention and post intervention The Cognitive functions were assessed by Stroop test on all the subjects.
- The subjects were randomly divided into four groups: Fig 1

Warm up 5 minutes spot Marching

Group A	Group B	Group C	Group D
The subjects were be trained to perform SN with Mild intensity postures. Each posture was held for 30 seconds. Each round of 12 postures took 6 minutes to complete and three –four rounds were performed in 20 minutes	The subjects were trained to perform SN with Moderate intensity so that all 12 postures were complete in 3 minutes. Six – Seven rounds were performed in 20 minutes.	The subjects were trained to perform SN with vigorous intensity so that all 12 postures were completed in 2 minute. Ten rounds were performed in 20 minutes.	The Subjects were attending regular physical activity sessions at their respective schools.

Cool Down 5 Minutes Spot Marching

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Ethical approval: PERC/PPSU/23/25

- **Statistical Analyses:** The data was obtained and entered in Microsoft Excel Version 13. The data was subjected to Statistical Analysis using IBM Statistical Package for Social Science version 21. For continuous data, mean and standard deviation (SD) was obtained. For pre and post comparison of the variables, Students Paired t test was applied. For comparison between group A, B, C and D, ANOVA with post hoc Tukey's was applied. All the statistical tests were applied keeping confidence interval at 95% and ($p<0.05$) was considered to be statistically significant

Fig 1 Performance of Suryanamaskar

- **Flow of the Participants through each stage of the RCT**

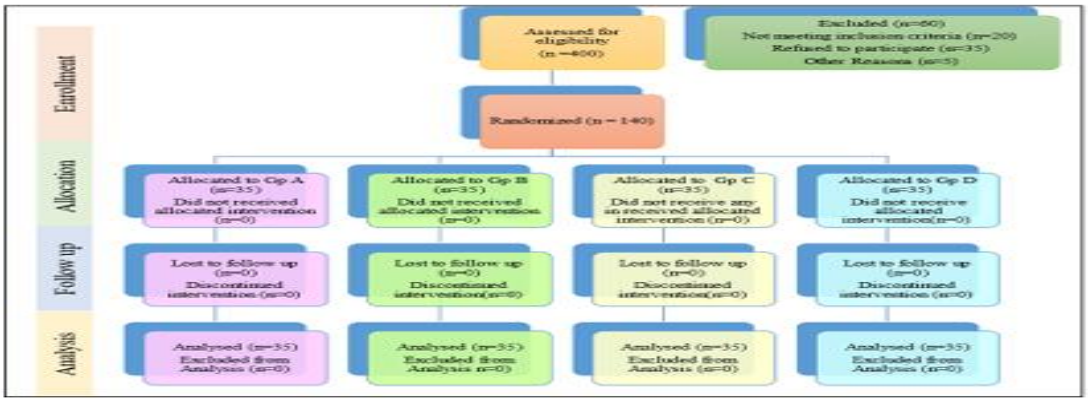

Fig. 5 Flow of participants through each stage of the RCT

DATA ANALYSIS AND INTERPRETATION

Pre and Post Intervention Comparisons

Pre and Post Comparison of Stroop Test in Group A

		N	Mean	Std. Deviation	Std. Error Mean	Mean Difference	T	P Value
Stroop Test	Pre	36	11.5000	2.13140	.35523	1.22222	3.449	.001
	Post	36	10.2778	2.26288	.37715			

When Pre and Post Comparison of Stroop Test Group A it was observed that the Difference in Mean was 1.22 and this difference in Mean was statistically significant. ($p<0.05$)

Pre and Post Comparison of Stroop Test in Group B

		N	Mean	Std. Deviation	Std. Error Mean	Mean Difference	T	P Value
Stroop Test	Pre	36	10.5556	2.50079	.41680	1.77778	7.228	.000
	Post	36	8.7778	1.64075	.27346			

When Pre and Post Comparison of Stroop Test in Group B it was observed that the Difference in Mean was 1.77 this difference in Mean was statistically significant. ($p<0.05$)

Pre and Post Comparison of Stroop Test in Group C

		N	Mean	Std. Deviation	Std. Error Mean	Mean Difference	T	P Value
Stroop Test	Pre	36	12.3056	1.76990	.29498	1.77778	6.181	.000
	Post	36	10.5278	1.78063	.29677			

When Pre and Post Comparison of Stroop Test in Group C it was observed that the Difference in Mean was 1.77 and this difference in Mean was statistically significant. ($p<0.05$)

Pre and Post Comparison of Stroop Test in Group D

		N	Mean	Std. Deviation	Std. Error Mean	Mean Difference	T	P Value
Stroop Test	Pre	36	10.5833[a]	1.97665	.32944	0.00	0	1.000
	Post	36	10.5833[a]	1.97665	.32944			
	Post	36	23.7224	4.31823	.71971			

When Pre and Post Comparison of Stroop Test, in Group D it was observed that the Difference in Mean was 0.00, and this difference in Mean was statistically significant ($p<0.05$) except for Stroop test value

Pairwise Comparison of the Change in Stroop Test Value between Groups

Multiple Comparisons						
Dependent Variable: Stroop Test						
Tukey HSD						
(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	P Value	95% Confidence Interval	
					Lower Bound	Upper Bound
Group A	Group B	.55556	.36659	.431	-.3976	1.5088
	Group C	.55556	.36659	.431	-.3976	1.5088
	Group D	-1.22222	.36659	.006	-2.1754	-.2690
Group B	Group C	.00000	.36659	1.000	-.9532	.9532
	Group D	-1.77778	.36659	.000	-2.7310	-.8246
Group C	Group D	-1.77778	.36659	.000	-2.7310	-.8246

CONCLUSION, IMPLICATION AND RECOMMENDATION

This study assessed a 12-week Suryanamaskar protocol with three different intensities and compared them with each other and the school/junior college based physical education programme. The outcomes, was Cognition which was measured by Stroop test.

Stroop Test

• Groups A, B, and C showed significant pre-post reductions (improvements), while Group D had no change. Pairwise comparisons revealed:

Groups B and C had larger improvements than Group A ($p < .001$).

Interpretation: The intervention was most effective for cognitive performance in Groups B and C.

Improvement in Cognition:

The Cognition in all the groups has significantly improved; the possible reasons could be increased in neuroplasticity which helps on the release of neurotrophic factors such as peripheral BDNF. Brain-derived neurotrophic factor (BDNF) plays a vital role in neuronal remodelling, synaptic plasticity, and neurotransmitter release, and acute aerobic exercise can enhance BDNF in the hippocampus. Also the different intensities of Surya namaskar increases cerebral blood flow and oxygenation to the brain tissue and thus enhances the neurotransmitter availability and neural efficiency, which promotes cognitive function. Also the incorporation of different intensities of Suryanamaskar, improves sleep which would promote the clearance of amyloid-β oligomers and the increase in neural synchrony in the prefrontal cortex. This area of prefrontal cortex is the area of the brain, which is responsible for cognition. The Similar results was found by Cassilhas et al., (2021) and Clark and Paunovic (2018) that walking exercise performed at different intensities and frequencies can improve cognitive performance after controlling for several confounding factors that are known to affect cognition, such as noise and atmospheric pollutants.

Our study showed that moderate intensity of Surya namaskar is found to be more significant as compared to other groups because moderate-intensity exercise formed positive changes in brain activation patterns for executive function, causing increased bilateral prefrontal activation levels in children. This can cause the immediate release of neurotransmitters (dopamine, serotonin), hormones (noradrenaline, growth hormone), and other chemicals; thus, the transient regulatory role that could be exerted by it improves the execution capacity. These findings are supported by the inverted U arousal theory. Also intervention lasting for 8-12 weeks can effectively improve children's executive function. The reason may be that long-term exercise intervention is a process of repetitive practice and constant use of executive functions. Throughout the intervention cycle, the individual's multiple thoughts intersect, create, and imagine so that the experience is constantly reinforced and cognitive functions are improved, which develops executive functions. Research shows that long-term exercise can cause changes in brain structure, resulting in changes in brain cells and molecules that contribute to neuroplasticity. By releasing neurotrophic factors, neurons in the hippocampal gyrus can obtain sufficient nutrients to increase their volume and ultimately strengthen memory and cognitive function.

CONCLUSION AND RECOMMENDATION Based on the findings, we recommend that schools optimize their physical education programs by incorporating more moderate and higher high-intensity Suryanamaskar, thereby promoting cognitive growth of adolescents through effective exercise.

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