

Short Communications

Effectiveness of aerobic exercise on short-term memory and sustained attention among school students**B. Sujatha¹, Jagatheesan Alagesan², B. Pavithra³, P. Pavithra³, A. Brite Saghaya Rayna³**¹Assistant Professor, ²Principal, ³Saveetha College of Physiotherapy, Saveetha Institute of Medical and Technical Sciences, Chennai, Tamil Nadu, India*(Received: October 2019**Revised: April 2020**Accepted: May 2020)*Corresponding author: **Sujatha B.** Email: rainabrite@gmail.com**ABSTRACT**

Reduced physical activity, there is a problem in health and cognitive function. There is evidence from the high-quality studies to strongly support the positive relationship between increased level of physical activity increases the function of the brain especially the cognitive function like short term memory and sustain attention function, so the study aims to determine the effects of aerobic exercise on the short-term memory and sustained attention among school students. 30 school going students were selected as subjects considering the inclusion and exclusion criteria. Study Type: Single group quasi-experimental study design. Study setting: samples are chosen from a school at Chennai according to inclusion and exclusion criteria. Sampling technique: Random sampling technique. Sample Size: 30 subjects. 30 school going students were engaged as participants in high-intensity interval training for 20 minutes, cycling bouts at the intensity with the upkeep of pulse of 70-89%. Statistical analysis was carried out for the collected data using descriptive and inferential statistics. Mean and standard deviation was calculated for different parameters in pre-test and post-test and the data were computerized and analyzed. The mean value and standard errors were calculated for different variables and the difference in mean value was tested for statistical significance using a paired t-test. A p-value of <0.0001 was considered as statistically significant. It has been concluded that the present study evaluated the impact of aerobic exercise, high-intensity interval training intervention on cognitive performance of short-term memory, and sustained attention in school students. The result demonstrated that the high-intensity interval training improved the subject's short-term memory and sustained attention following the pre-test and post-test results of the Stroop test and digit span test.

Keywords: Cognition; short-term memory; children; aerobic exercise.**INTRODUCTION**

Physical inactivity is due to a widespread sedentary lifestyle. This lifestyle change is associated with a substantial increase in obesity, high blood pressure, high cholesterol, type 2 diabetes, and coronary heart disease throughout the life span during childhood. Regular physical activity has been shown to scale back the morbidity and motility related to many of those chronic diseases. A large body of research shows that physical activity improves cognitive functioning (1).

A sedentary lifestyle during childhood not only influences physical health but cognitive & brain health as well. Compare with the past decade, preschool-age children significantly fewer bouts of physical activity during the school day due to decrease time spent in recess and outdoor play (2).

Prevalence of Country-level physical inactivity levels of youngsters in India are not available but smaller regional studies provide some insight. A recent study evaluating physical activity levels in school-aged children ages of 5 to 14 years from major cities in India including Bengaluru, Chennai, Hyderabad, Kolkata, Mumbai, New Delhi, and Surat used parent report and child self-report to estimate that 21% of children were inactive, 18% engaged in physical

activity at least once per week, 21% engaged in physical activity two or three times per week, 40% engaged in physical activity more than three times per week (3).

Moderate aerobic exercise is defined as exercise, which noticeably accelerates HR & requires 3.0 to 6.0 metabolic equivalents (METs) (eg., slow cycling, brisk walking, or swimming). High-intensity interval training describes workout, i.e., characterized by brief, intermittent bursts of vigorous activity, interspersed by periods of rest or low-intensity exercise. HIT has been recently proposed as a time-efficient alternative to traditional cardio-respiratory exercise. An efficient high-intensity interval training protocol consists of 10 × 60 sec. work bouts at a constant-load intensity that elicits ~90% of maximal pulse (HR; that correspond to ~80% of the reserve HR), interspersed with 60 sec. of recovery (4-6).

Short-term memory and sustained attention is one of the important cognitive function functions implicated in a variety of daily living activities. Sustained attention is "the ability to direct and focus cognitive activity on specific stimuli". In order to complete any cognitively planned activity, any sequenced action, or any thought one must use sustain attention. For example, in an act of reading a newspaper article one

must be able to focus on the activity of reading long enough to complete the task (7). Problems occur when a distraction arises. A distraction can interrupt and consequently interfere in sustained attention. When a person has difficulty sustaining attention, they often present with an accompanying inability to adapt to environmental demands or modify behavior (8).

Short-term memory is that ability for holding, but not manipulating, a little amount of data in mind in a lively, readily available state for a brief period. The duration of short-term memory seems to be between 15 to 30 seconds and capacity about 7 items. Digit span test is a measuring tool for short-term memory. Stroop test may be a demonstration of interference within the response time of a task. When the name of a color (eg., blue, green, red) is printed in a color which is denoted by the name (ie. word red printed in blue ink instead of red ink) (9).

Digit span is the longest list of items that a person can repeat back in correct order immediately after a presentation on 50% of all trials is a common measure of short-term memory. Participants hear a sequence of numerical digits are asked to recall the sequence correctly, with an increasingly longer sequence of being tested each trial. There is a possibility that susceptibility to proactive interference affects performance on memory span measures (10).

Due to reduced physical activity, there is a problem in health and cognitive function. There is evidence from the high-quality studies to strongly support the positive relationship between increased level of physical activity increases the function of the brain especially the cognitive function like short term memory and sustain attention function. Therefore, in this study, we are trying to focus on the improvement of cognitive function like short-term memory and sustained attention among school students.

MATERIALS AND METHODS

Thirty subjects of school students were selected according to inclusion and exclusion criteria. Study Type: single group quasi-experimental study design. Study setting: sample is selected from a school at Chennai according to the inclusion and exclusion criteria. Sampling Technique: Random sampling technique. Sample Size: 30 subjects. Inclusion criteria: Both genders, Age group 15 to 16 years, and did not have any musculoskeletal disorders. Exclusion criteria: BP greater than or equal to 150/90mm hg, cerebral dysfunction, cardiovascular problem, and Allergies. Procedure: 30 participants of school students were engaged in high-intensity interval training for 20 minutes, cycling bouts at the intensity with the maintenance of heart rate of 70-89%. Before and after the Stroop assessed the experimental session cognitive performance, test (sustained attention) and digit span test (short term

memory). Outcome measures: Stroop test, and Digit span test.

Treatment procedure

Vitals (BP, HR, pulse rate, respiratory rate) have been checked before starting the treatment procedure.

- Warm-up phase. (10 minutes)
- Condition phase (20 minutes)
- Cool down phase (10 minutes)

The study was conducted as 3 sessions. In the 1st session, the subject performed two pre-intervention working memory tests: Digit span test and "Stroop test" and values have been recorded and the 2nd session is a physical activity session in which the high intensity interval training has been given. And the last session is the post-intervention session immediately after the post-intervention memory test, and values have been recorded. This procedure has been given for the school students for 4 weeks, 3 days per week has been implemented and recorded.

High intensity interval training

Warm up phase

Stretching (3mins): Hamstring, quadriceps, gastrosoleus (each muscle for 15 secs, 3 repetitions, and rest period between each muscle is 15 secs).

Active range of motion (7minutes for both upper limb and lower limb).

Upper limb

- Shoulder: flexion, extension, abduction, adduction, internal rotation, and external rotation.
- Elbow: flexion and extension.
- Forearm: supination and pronation.
- Wrist: flexion, extension, ulnar deviation, and radial deviation.
- Fingers: flexion, extension, abduction, adduction, and opposition.

Lower limb

- Hip: flexion, extension, abduction, adduction, internal rotation, and external rotation.
- Knee: flexion and extension.
- Ankle: dorsiflexion, plantar flexion, inversion, and eversion.
- Toes: flexion, extension, abduction and adduction.

Conditioning phase

Subjects have been asked to peddle in bicycle ergometer for 20 minutes (4*1 minute; 4min= peddling, 1min= recovering, gradually decreasing the intensity by 60 rotation per min) with the maintenance of percentage peak heart rate between 70-89%. This percentage peak heart rate has been monitored by using the pulse oxymeter.

Cool down phase

Stretching (3minutes): Hamstring, quadriceps, gastrosoleus (each muscle for 15 secs, 3 repetitions,

and rest period between each muscle is 15 secs). Active range of motion (7minutes) for both upper limb and lower limb.

Upper limb

- Shoulder: flexion, extension, abduction, adduction, internal rotation, and external rotation.
- Elbow: flexion and extension.
- Forearm: supination and pronation.
- Wrist: flexion, extension, ulnar deviation, radial deviation.
- Fingers: flexion, extension abduction, adduction, and opposition.

Lower limb

- Hip: flexion, extension, abduction, adduction, internal rotation, and external rotation.
- Knee: flexion and extension.
- Ankle: dorsiflexion, plantar flexion, inversion, and eversion.
- Toes: flexion, extension, abduction and adduction.

Outcome measure procedures

Stroop test

This procedure is completed by 20 sequences of 5 color words that were printed on the paper. Each paper was given to the participants, as they were asked to call out the color of the ink and asked to call out the color of the word. The average time is taken to say the color of the ink and the color of the word is noted, the difference between the average time taken between the word and the printed color is noted. The average differences between the pre and post results were calculated. Before and after the intervention, pre and post-test values were calculated. When there's a decrease in time consumption compare to the pre-test and post-test values indicate the development within the outcome measure.

Digit span test

The test is known as the digit span test were numbers are used. The Digit span test is the common measure of short-term memory. Short-term memory is a component of cognitive skills. In the test, a sequence of numbers is listed in the paper. The number were arranged in sets of those being of the same length. The subjects were asked to read out the list of digits in order in which we said. If it seems to unclear about what is required to go through an example say the list 4, 7, 1 read the digit in an even tone at approximately the rate of one digit per second. The participants have been tested to six lists, starting with length. They were read out the digits at the rate of one digit per second. In the space provided tick mark has been put if the subject repeats the list correctly and cross if they do not. If the subjects get at least 5 out of 6 correct, proceeded to the set of next set. Continue procedure until the subject gets the lists from the set

wrongly. Participants, digit span test as the maximum length of the list of which the subject recalled at level 5/6 correctly. Before and after the intervention the pre-test and post-test values have been calculated. When there is a decrease in time consumption compare to the pre-test and post-test values indicate the improvement in the outcome measure.

RESULTS

The collected data was tabulated and analyzed using descriptive and inferential statistics. To all parameters mean and standard deviation (SD) was used. Paired t-test was used to analyze significant changes between pre and post-test measurements. P-value <0.05 was considered as statistically significant. The data from the above table 1 show the pretest and post -test values of Stroop test in participants.

The pre-test mean value of Stroop test is 10.20 (S.D.3.58) and post-test mean value of Stroop test is 7.80 (S.D. 3.49) this shows that Stroop test values are gradually increasing in the P-value. ($p > 0.0001$) and shows statistical significance. The data from the above table 2 shows the pre-test and post-test value of digit span test in participants.

The pre-test mean value of digit span test is 0.537 with S.D. 0.192 and post-test mean value of digit span test is 0.460 with S.D. 0.157. this shows that digit span test values are gradually increasing with the p-value (0.001) statistically significant. From the statistical analysis made with the quantitative data relieved a statistically slight difference between pre-test and post-test. The post-test value of Stroop test is 7.80 and pre-test is 10.20 there is a slight decrease in the mean value this shows that Stroop test due to the aerobic exercise of high-intensity interval training, intervention was slightly improved. P-value is less than <0.001. The post-test value of digit span test is 0.460 and the pre-test is 0.537 from this there is a slight difference in the statistical mean. P-value is equal to 0.001. Statistical analysis of both the Stroop test and the digit span test revealed that there is a slight statistical difference seen in both the pre-test and post-test values.

Table 1: Pre-test and post-test of Stroop test

Group	Mean	S.D.	T-value	P-value
Pre-test	10.20	3.58	6.2279	>0.0001
Post-test	7.80	3.49		

Table 2: Pre-test and post-test of Digit Span test

Group	Mean	S.D.	T-value	P-value
Pre-test	0.537	0.192	4.4899	0.001
Post-test	0.460	0.157		

DISCUSSION

Aerobic exercise may be a workout of low to high intensity that depends totally on the aerobic energy-

generating process. Aerobic means "Relating to involving or requiring free oxygen" and refers to the use of oxygen to adequately meet energy demand during exercise via aerobic metabolism generally high to moderate-intensity activities that are sufficiently supported by aerobic metabolism are often performed for extended periods of your time 11. The aim of this study was to work out the effectiveness of aerobics on short term memory and sustained attention among school children. 30 subjects fulfilling the inclusion criteria were assigned to the present study by randomization technique. Subjects were assigned into one group and high intensity interval training was given. consent was taken from the themes and therefore the procedure was explained. Single group (n=30) were receiving a high intensity interval training intervention over a period of 4 weeks, 3 days/ week. Stroop test and digit span test were used as the tools for analysis the sustained attention and short-term memory. The outcome measures were taken before, after the intervention, and after the end of the 4th week.

Fincham *et al.*, discussed that the aim of this study was to gauge the impact of a 4 weeks high intensity interval training intervention on cognitive performance in emerging adults. High intensity interval training shortly improved their mathematic and reading working memory scores from pre-test to post-test (12). The objective of the study of Alves *et al.*, was to assess the effect of an acute high intensity interval training session on selected parameters of cognitive function like executive function and short-term memory performance in middle aged groups. The main finding was that the high intensity interval training sessions improve the performance in the Stroop "color word" test, which has been thought to be a measure of selective attention and therefore the susceptibility to interference from conflicting stimuli. Conversely, the high intensity interval training slightly improved the performance in the digit span forward test has been considered as a measure of short-term memory. Some authors have speculated that the exercise intensity affects the cognitive performance in u-shaped fashion, meaning that a high intensity exercise would improve cognition were as moderate intensity would impair cognition (13).

Tomposiki *et al.*, discussed that the study was to further investigate if exercise. In the form of interval, training has an effect on memory function. It was hypothesized that exercise training that includes intermittent bouts of bicycling will have a positive effect on memory retention. Past studies have shown that acute continuous high intensity interval training improves cognitive function these past studies used the Stroop test to measure cognitive function (14). The present study combined the success to investigate if moderate intensity interval training could also benefit cognitive performance using a list

of 15 randomly generated words rather than a Stroop test.

Yanagisawa *et al.*, found that submaximal aerobics greatly increased cognitive function, but during continued bouts of extended, strenuous exercise resulting in dehydration both information science and memory cognition were compromised (15).

In the study of Hillman *et al.*, (16) there is no significant difference in short term test scores, long term memory test scores, or absolute memory retention between the control and experimental groups. The short term and long-term memory assessments that participants who studied the material while exercising. There is no significant correlation could be found out in both the pre and post-test .

Mcdonald *et al.*, (17) have discussed that from in his studies he has hypothesized, that acute aerobic exercise increases working memory. With regular running and cycling bout increases the short-term memory.

The present study reveals the subjects who received the high intensity interval training shows that the slight improvement in the subjects' short-term memory and sustained attention by concluding the pre-test and post-test result of Stroop test and digit span test.

CONCLUSION

It has been concluded that the present study evaluated the impact of an aerobics of high intensity interval training intervention on cognitive performance of STM and sustained attention in students of a school. The result demonstrates the high intensity interval training improved the subjects' STM and sustained attention by following the pre and post-test values of Stroop test and digit span test.

CONFLICT OF INTEREST: Declared no conflict of interest.

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