ORIGINAL RESEARCH PAPER
Volume - 15 | Issue - 08 | August - 2026 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

COMPARISON OF COGNITIVE FUNCTIONS IN TRAINED REGULAR SWIMMERS OF 8-18 AGE GROUP WITH THEIR NON-SWIMMER COUNTERPARTS IN MAHARASHTRA

Human Physiology

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ABSTRACT

Background: The Age 8-18 is considered most important for the development of cognitive functions. For the development of cognitive function, it is not necessary to have an adequate intelligence quotient, but also a matter of social factors. Nowadays, children are busier with studying, screening, and games, which causes a negative impact on cognitive function. According to previous studies, it is shown that sports significantly develop cognitive functions. **Aims and objectives:** to compare cognitive functions in trained regular swimmers and their non-swimmer counterparts. **Material and methods**: 90 participants, including 45 swimmers and 45 non-swimmers, were selected for the study. swimmers were selected based on participation in national and international events. Those not participating in sports are considered non-swimmers. 3 tests carried out include Reaction time, Digit Span test (forward and backward), and Stroop test by using standard test manuals. **Results:** The study shows that Swimmers have significantly less reaction time compared to non-swimmers, Swimmers repeated a higher no. of sequences in the digit span test compared to non-swimmers, and swimmers showed significantly lower Stroop test timing compared to non-swimmers. **Conclusion:** Swimmers showed developed cognitive function compared to non-swimmer counterparts.

KEYWORDS

INTRODUCTION:

The development of children and adolescents aged 8 to 18 years encompasses a wide range of physical, cognitive, and emotional changes. This period is marked by significant growth spurts, the onset of puberty, and the development of complex cognitive and emotional skills. Understanding these changes is crucial for supporting healthy development during these formative years.As per Jean Piaget, cognitive development in children includes 4 stages: the Sensorimotor stage from age 0 to 2, the Pre-operational stage from 2 to 7 years of age, from age 8 to 11 lasts stage of operational development stage and which usually lasts a lifetime, is the formal operational stage. All these stages are very important because various cognitive developmental milestones occur in these stages. Which includes factors such as understanding language, reaction to various factors, social exposure, interaction with others, and memory.. [1]

Cognitive development in children is subject to a multitude of influences, including nutritional status, social determinants, and exposure to linguistic stimuli. [2]

In modern society, children are predominantly subjected to electronic devices such as mobile phones, computer screens, and televisions. Excessive screen time may hurt cognitive development [3].

Not only due to augmented screen time, but also as a result of the COVID-19 pandemic, children have demonstrated significant cognitive impairments attributed to lockdown measures and social isolation. [4]

Existing scholarly literature suggests that the enhancement of cognitive function in children requires not only a high intelligence quotient but also underscores the importance of sports participation, as involvement in sports promotes the development of executive functions [5] Children who engage in after-school sports demonstrate markedly improved cognitive functions, encompassing enhanced executive function capabilities, processing speed, and language comprehension when compared to their non-sporting peers. These findings highlight the advantageous effects of sports on cognitive health among youth.[6]

MATERIAL AND METHODS:

The decision was made to conduct three assessments: Reaction Time, the Stroop Test, and the Digit Span Test, with the guidance of a Clinical Psychologist affiliated with the Department of Psychiatry. Following the approval from the institutional ethics committee, the process of data collection commenced. The participants selected for the study were swimmers who were engaged in competitive training for five years and have maintained a regular training regimen over the past three weeks, specifically those involved in State, National, and International Championships, according to the criteria established by FINA (Federation of International Aquatics) and Swimming federation of India [7]. Children lacking any form of sports training were classified under the non-swimmer category. Individuals with a documented history of neurocognitive disorders, those currently on medication, as well as swimmers utilizing anabolic steroids, were excluded from participation in the study. A total of 90 subjects were chosen for the study, comprising 45 swimmers and 45 non-swimmers. The sample size was determined based on the formula for a Confidence Level of 95% with a Margin of Error of 5%, with the total population of National and State swimmers being 50; thus, the sample size of 45 was selected, ensuring equal representation among non-swimmers. Data collection was executed utilizing standardized charts for the Digit Span Test Forward (Digit Span Test F) and Digit Span Test Backward (Digit Span Test B) alongside standardized applications for the Reaction Time and Stroop Test.

Reaction time (RT) is defined as the interval between the onset of a stimulus and the initiation of a behavioral response, serving as a fundamental measure in various scientific disciplines, including cognitive psychology, neuroscience, and human factors research. We calculated reaction time using a standard application in which participants had to click on the screen when the color changed on the screen.

The Stroop Color and Word Test, often referred to as the Stroop test, is a widely used neuropsychological assessment tool designed to measure selective attention, cognitive flexibility, information processing speed, and executive function, particularly the ability to inhibit an overlearned response.

The Digit Span Test is a widely utilized neuropsychological assessment tool designed to evaluate verbal short-term memory and working memory capacity.

RESULTS:

The study group consisted of 45 swimmers and 45 non-swimmers.

Figure 1 shows the distribution of the study population with respect to gender. There were 24 males and 21 females among swimmers and 19 males and 26 females among non-swimmers.

Age of swimmers ranged from 8 years to 18 years, with an average age of 12.62± 2.9 yr. Age of non-swimmers ranged from 9 yr to 18 yrs, with average age of 12.75 ± 2.15 yr.

Average reaction time, digit span F, digit span B, and Stroop test are summarized in Table 1.

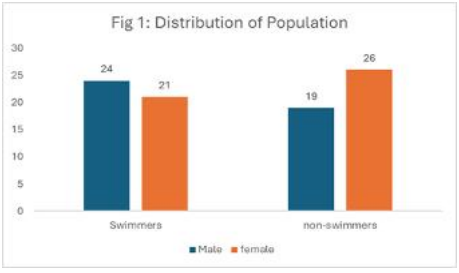

Table 1: Average reaction time, digit span F, digit span B and Stroop test of swimmers and Non- Swimmers

Variable	Swimmers Mean ± sd	Non-Swimmers Mean ± sd	t (p)
reaction time (ms)	230.02 ± 13.56	297.42 ± 40	9.32 (0.0001)**
digit span F	13.27 ± 0.38	7.64 ± 1.69	16.83 (0.0001)**
digit span B	11.26 ± 0.09	4.22 ± 1.68	21.34 (0.0001)**
Stroop test (ms)	1285.7 ± 259	1785.4 ± 444.5	6.28 (0.0001)**
** indicate significance at p <0.001			

Reaction Time: It was observed that the reaction time of swimmers ranged between 192ms to 260ms, while the range of reaction time of non-swimmers was 228ms to 403 ms. The average reaction time of swimmers was significantly lower than that of non-swimmers (Table 1).

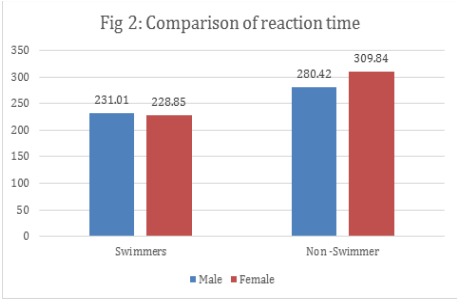

Table 2: Comparison of Reaction time of swimmers and non swimmers wrt gender

	Swimmers		Non -Swimmer		T	p
gender	Mean	± sd	mean	± sd		
Male	231.01	12.9	280.42	33.3	5.75	<0.0001
Female	228.85	14.15	309.84	39.9	8.43	<0.0001

Digit Span F: It was noted that the Digit Span F of swimmers ranged from 11 to 14, while there was wide variation among non-swimmers, ranging from 1 to 11. The Average Digit span F of swimmers was significantly more than that of non–swimmers (Table 1)

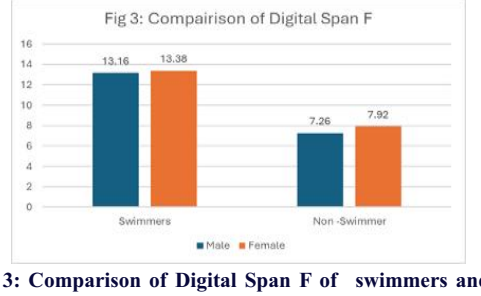

Table 3: Comparison of Digital Span F of swimmers and non swimmers wrt gender

	Swimmers		Non -Swimmer		t	p
gender	Mean	± sd	mean	± sd		
Male	13.16	0.98	7.26	1.91	9.4	<0.0001
Female	13.38	0.72	7.92	1.44	14.95	<0.0001

Digit Span B: Digit span B of swimmers ranged from 9 to 13 and was consistent with a mean of 11.26 ± 0.9. As against that, Digit span B of non-swimmers varied widely between 1 to 10 with a mean of 4.22±1.68. It was significantly lower than that of swimmers (Table 1).

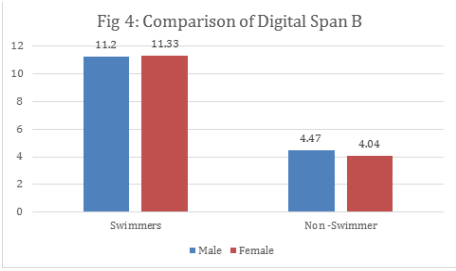

Table 4: Comparison of Digital Span B of swimmers and non swimmers wrt gender

	Swimmers		Non -Swimmer			
gender	mean	± sd	mean	± sd	T	p
Male	11.20	1.03	4.47	1.73	11.64	<0.0001
Female	11.33	0.71	4.04	1.51	18.38	<0.0001

Stroop test: The Stroop test ranged from 1000ms to 2500ms for swimmers with an average 1285.7ms ± 259ms and was significantly lower than that of non-swimmers, which ranged from 1200ms to 3158ms (Table 1).

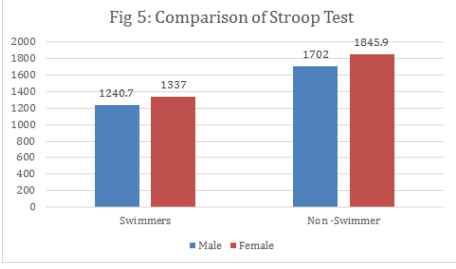

Table 5: Comparison of Stroop Test of swimmers and non swimmers wrt gender

	Swimmers		Non -Swimmer			
gender	mean	± sd	mean	± sd	t	p
Male	1240.7	101	1702.0	379	4.44	<0.0001
Female	1337.0	356.6	1845.9	477.5	4.08	<0.0001

Reaction Time: Fig. 2 depicts the average reaction time of males and females in swimmers and non-swimmers

It was observed that the reaction time of male swimmers ranged from 204ms to 260ms, while that of male non-swimmers ranged from 254ms to 403ms. Similarly, the reaction time of female swimmers ranged from 192ms to 253ms, and that of female non-swimmers ranged between 254ms to 403ms It was observed that the average reaction time of male as well as female swimmers was significantly lower than that of male and female non-swimmers. The results were statistically significant. (Table 2).

Digit Span F: Average Digit Span F is depicted in Fig. 3. It was observed that Digit Span F of male swimmers ranged from 11 to 14, while that of male non-swimmers ranged widely from 3 to 9. Similarly, the reaction time of female swimmers ranged from 12 to 14, while that of female non–swimmers ranged widely between 4 to 11.

It was observed that average Digit span F of male as well as female swimmers was significantly higher that of males and female non swimmers. The results were statistically significant. (Table 3).

Digital Span B: Average Digital Span B is depicted in Fig. 4. It can be seen that Digital Span B of males and females is comparable among swimmers as well as non-swimmers. It was observed that the Digital span B of male swimmers ranged from 9 to 11. However, there was wide variation in digital span B of male non-swimmers, which ranged from 1 to 8. Similarly, the Digital span B of female swimmers ranged from 10 to 12, while there was wide variation (2 to 10) in the digital span B of female non-swimmers.

It was observed that the average digit span B of male as well as female swimmers was significantly lower than that of males and female non-swimmers. The results were statistically significant. (Table 4).

Stroop Test: Average Stroop test is depicted in Fig 5 It was observed that Stroop test of male swimmers ranged from 1059ms to 1400 ms. whereas Stroop test of male non-swimmers ranged from 1200ms to2727ms Similarly Stroop test of female swimmers ranged from 1000ms to 2500ms while that of female non swimmers ranged from 1277ms to 3158ms.

It was observed that the average Stroop test of male as well as female swimmers was significantly lower than that of males and female non-swimmers. The results were statistically significant. (Table 5).

DISCUSSION:

Cognitive function tests reveal significant differences between swimmers and non-swimmers, particularly in areas such as attention, executive function, and neural efficiency. Swimmers, especially those with elite training, demonstrate enhanced cognitive performance linked to their physical activity, which may contribute to better mental resilience and cognitive aging. Elite swimmers exhibit superior attention, working memory, and executive control. Neuroimaging studies indicate that elite swimmers have sparser upper beta connectivity and enhanced alpha rhythm intensity, suggesting more efficient brain function during cognitive tasks [8].

Swimmers tend to perform better on cognitive function tests due to a combination of physical activity, psychological training, and neural efficiency associated with their sport. Research indicates that regular swimming enhances executive functions (EFs) such as working memory, cognitive flexibility, and behavioural inhibition. [9]

Swimmers scored higher in cognitive function tests due to the positive relationship between competitive swimming and cognitive abilities, including spatial relations, spatial ability, and reasoning ability, suggesting that the sport enhances these cognitive skills through its demands for coordination and decision-making. [10]

CONCLUSION:

Trained regular Swimmers show better cognitive functions, such as memory, and decision-making, and executive functions such as attention, processing speed, and cognitive control compared to their non-swimmer counterparts.

Acknowledgment:
Mr. Gokul Kamat, Head Swimming Coach

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