

# ENHANCING SELECTIVE ATTENTION: A COMPARATIVE STUDY OF MODERATE-INTENSITY EXERCISE AND HIGH-INTENSITY INTERVAL EXERCISE IN YOUNG ADULTS

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## ABSTRACT

**Objectives:** The principal aim of this study was to determine the impact of moderate-intensity exercise and high-intensity interval exercise on selective attention.

**Materials and Methods:** This experimental study transpired at Khyber Girls Medical College Peshawar from August 2020 to March 2021. Thirty-four young adults were enlisted, participating in two sequential experimental sessions. In the initial session, subjects engaged in a 20-minute session of moderate-intensity exercise, with forward digit span tests administered both pre and post-exercise. Following a one-week interval, the second session involved the same procedures, with participants undertaking high-intensity interval exercise characterized by alternating one-minute intervals of low and high-intensity activities. Selective attention was re-evaluated within 5 minutes of completing the exercise. Participants were then scheduled for a follow-up session one week later, where the same procedures were replicated. SPSS version 20 was used for Data analysis, with statistical significance set at  $P < 0.05$ . Shapiro-Wilk test was used to assess the normality of the data.

**Results:** thirty-four participants with a mean age of  $21 \pm 2$  years, a body mass index (BMI) of  $23 \pm 4$  kg/m<sup>2</sup>, and a mean waist-hip ratio of  $0.81 \pm 0.05$  were included in the study. After fifteen minutes of high-intensity interval exercise, a noteworthy improvement in selective attention was observed ( $P = 0.001$ ).

**Conclusion:** A single session of high-intensity interval exercise exhibited greater efficacy in enhancing selective attention as compared to moderate exercise.

**Keywords:** High-intensity interval exercise, Selective attention, Young adults

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## INTRODUCTION

Physical exercise (PE) is described as an organized and repetitive component of physical activity with the ultimate or intermediate goal of preserving or enhancing physical fitness.<sup>1</sup>

Various forms of physical exercise exist, categorized based on the percentage of maximum heart rate (HR max) at which they are conducted. Specifically, exercises executed at 50 - 63%, 64 - 76%, and 77 - 95% of HR max is

designated as low, moderate, and high-intensity exercises, respectively. Furthermore, high-intensity exercise can be subcategorized into continuous, high-intensity interval training (HIIT) and sprint interval training. HIIT is a form of physical exercise distinguished by brief intervals of intense exercise interspersed with equal durations of rest or lower-intensity physical activity.<sup>2</sup>

While physical exercise has a beneficial impact on selective attention and consequently memory. Regrettably, a substantial portion of the global population does not maintain an adequate level of physical activity. According to a survey conducted by the World Health Organization, 23% of males and 32% of females worldwide fall short of engaging in the recommended amount of physical activity. Furthermore, merely 5% of the adult population worldwide adheres to the fundamental guidelines for regular physical exercise.<sup>3</sup>

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Top of Form In the context of Pakistan, the situation is grim, with 24.4% of males and 43.3% of females having lower than required level exercise. The cited reasons for noncompliance with exercise and the prevalence of sedentary behavior include perceived time constraints and the extensive use of internet-enabled devices such as cell phones and computers. <sup>4</sup> Fortuitously, HIIT requires less time investment in comparison to sustained moderate exercise, rendering it a preferred choice for a majority of individuals. <sup>5</sup> Top of FormIt has recently surfaced as an efficacious exercise paradigm conducive to cognitive well-being. <sup>6</sup>

The principal benefit of High-Intensity Interval Training (HIIT) lies in its capacity to offer a robust stimulus for neuronal growth. HIIT, notably, proves advantageous in regulating attention and facilitating the selective filtering of irrelevant information during the execution of cognitive tasks. <sup>7</sup>

Selective attention enables the discernment and filtration of irrelevant information, facilitating concentration on pertinent stimuli. Additionally, it constitutes a foundational element for the acquisition of complex knowledge. Few studies aim to investigate the impact of High-Intensity Interval Training (HIIT) on selective attention. Further exploration is justified to delineate the effects of HIIT on brain health. <sup>8,9</sup> Top of Form Our research endeavors to contribute to the extended body of knowledge by examining HIIT on selective attention in the young adult population.

## MATERIALS AND METHODS

This experimental study was conducted at the Physiology Department, Khyber Girls Medical College Peshawar. The sample size for the within-subject design was determined through power analysis and effect size, drawing from previous findings by Labban et al. <sup>10</sup> The power analysis was computed using an effect size of 0.50 for a power of 0.80 and, a sample size of 34 participants was chosen.

After being approved by the ethical committee of Khyber Medical University, volunteers were registered through notices, personal contacts, and circulars. Young female adults aged 18–25 were chosen, ensuring they had no history of psychiatric medications, psychiatric illnesses, smoking, or musculoskeletal and neurological disorders. Additionally, all participants met the exercise fitness criteria, assessed through the Physical Activity Readiness Questionnaire. <sup>11</sup>

Upon obtaining informed consent, anthropometric measurements, including weight, height, waist circumference, and hip circumference, were recorded for all participants. The intensity of exercise i.e. low, moderate, and high was determined based on individual age. Maximum heart rate (HR max) was calculated for each participant with the help of formula  $220 - \text{age}$ . <sup>12</sup> The percentage of HR max was used to categorize exercise into low, moderate, and high intensity levels and the range of HR max was 50-63%, 64-76%, and 77-95%, respectively. High-intensity interval exercise involved alternating one-minute bouts of high-intensity exercise with equal durations of low-intensity exercise. <sup>13</sup> Body mass index (BMI) was calculated using Quetelet's formula, according to which weight in kilograms is divided by the square of height in meters to get BMI. <sup>14</sup> A within-group study design was used, according to which, all the participants were scheduled for 2 experimental sessions. Participants were given instructions that they should not consume any drink that contains caffeine including tea for at least 24 hours before the experiment.

On the first experimental day, pre-exercise selective attention was evaluated using the Forward Digit Span Test (FDST). This test is widely employed in clinical and research settings, demonstrating high validity and reliability among healthy adults. It serves as a subset of Wechsler's Adult Intelligence Scale. <sup>15</sup> Following the initial test, participants engaged in 15 minutes of moderate exercise on the treadmill (American Fitness, LK700T CORE) tailored to their intensity levels.

Continuous monitoring ensured that their heart rates remained within the specified ranges for moderate exercise. Selective attention was re-evaluated within 5 minutes of completing the exercise, using the Digit Span Forward Test. Participants were then scheduled for a follow-up session one week later, where the same procedures were replicated. However, during this second session, participants performed a 15-minute bout of high-intensity interval exercise.

SPSS version 20 was used for Data analysis, with statistical significance set at  $P < 0.05$ . Shapiro-Wilk test was used to assess the normality of the data.

## RESULTS

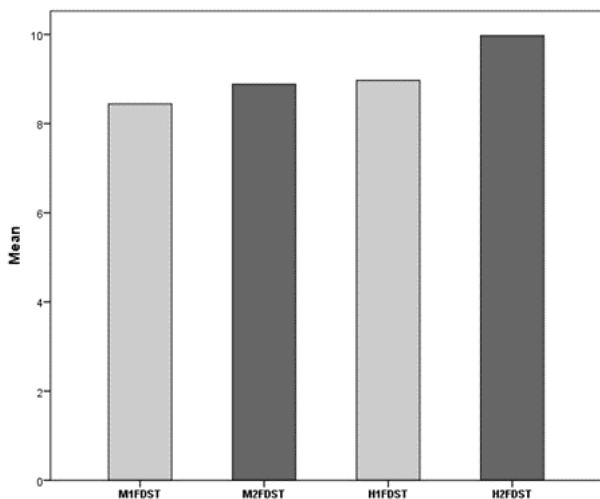
The participants had a mean age of  $20 \pm 1$  SD, a mean BMI of  $23 \pm 4$  (kg/m<sup>2</sup>), and a mean waist-hip circumference ratio of  $0.81 \pm 0.05$ . During moderate exercise, the average heart rate ranged from 122 to 152

beats per minute, while for high intensity, most participants achieved a heart rate between 153 and 190 beats per minute. Forward Digit Span Test (FDST), the Wilcoxon signed-rank test indicated a positive significant change with a z-value of -1.422,  $p = 0.15$ , and a small effect size ( $r = .1$ ) for moderate-intensity exercise (MIE). For high-intensity interval exercise (HIIE), the Wilcoxon signed-rank test showed a z-value of -3.182,  $p = 0.001$ , with a medium effect size ( $r = .4$ ).

**Table No 1: Forward Digit Span Test Scores After Exercise**

Type of exercise	Forward Digit Span Test Scores		P value
	Mean $\pm$ SD (n = 34)	Effect size	
M1	8.41 $\pm$ 2	.1	0.15
M2	8.86 $\pm$ 2		
H1	8.86 $\pm$ 1	.4	0.001
H2	9.86 $\pm$ 1		

M1 = before moderate exercise, M2 = after moderate exercise, H1 = before high intensity interval exercise, H2 = after high intensity interval exercise,  $P < 0.05^*$ ,  $P < 0.01^{**}$



**Fig 1: Forward Digit Span Test Scores pre and post-exercise FDST = Forward digit span test, M1 = pre moderate exercise, M2 = post-moderate exercise, H1 = pre high-intensity interval exercise, H2 = post high-intensity interval exercise**

**DISCUSSION**

The objective of the study was to determine the impact of an acute High-Intensity Interval Training (HIIT) session on a specific cognitive function, namely selective attention, in young adults. Selective attention was assessed using the Digit Span Forward Test (FDST). According to the results, there was no significant effect of moderate exercise on attention ( $P = 0.15$ ). On the other hand, there was a significant effect of HIIT on attention ( $P = 0.001$ ).

Our results are consistent with previous research, which demonstrated that there was a positive influence of High-Intensity Interval Training (HIIT) on cognitive functions, including attention. The various tests and measures utilized by these studies were Victoria Stroop test, Reaction Time test, and Digit Span tests, all of which have demonstrated improvements in cognitive performance following HIIT.<sup>16-18</sup>

In a similar study conducted by Walsh et al. (2018) on university students, the effect size analysis unveiled a moderate effect size of 0.459 in favor of High-Intensity Interval Exercise (HIIE), which was statistically significant with a P-value of 0.01.<sup>19</sup> Our study reported similar results with an effect size of 0.486 and a statistically significant P-value of 0.001, which indicates a substantial impact. Moreover, our results are also consistent with a study done at the University of Boston, which evaluated declarative memory, selective attention, and inhibitory control. The uniformity in these studies indicates a strong relationship between cognitive processes and high-intensity interval exercise.<sup>17</sup> On the contrary to these studies, the results of a study done by Alves et al. (2014) were different from our results as no significant effect was found on Forward Digit Span Test (FDST). This difference could be attributed to older age group as mean age of participants in their study was 53 years, which might suggest that age-related factors may play a role in the cognitive response to HIIT. This highlights how crucial it is to take in account the demographics of participants while analyzing the effect of HIIT on cognitive function.<sup>20</sup>

The benefits of HIIT on cognition are further supported by a study by Kao et al, who demonstrated the advantages of HIIT on inhibitory control in both young adult females and males. This highlights the uniqueness of the effect of HIIT on cognition, supporting the theory that different cognitive domains may respond to it differently.<sup>17</sup> Results of another study conducted on individuals aged eight to ten years also contribute to evidence that HIIT effects cognition positively.

In this particular study, Stroop performance was significantly improved just one minute after HIIE ( $P < 0.01$ ). Furthermore, these improvements were sustained for up to 30 minutes after the cessation of exercise. This suggests that the cognitive benefits of HIIE may manifest rapidly and endure beyond the exercise session, particularly in the context of children in this age group.<sup>21</sup>

The study conducted by Tsukamoto, involving 10 male participants evaluated the arousal level of participants by using the Felt Arousal Scale and for measuring attention they used the Color Word Stroop Task. The results revealed a significant increase in attention levels after High-Intensity Interval Exercise (HIIE). This further supports the notion that HIIE can have a positive impact on cognitive functions, including attention, as evidenced by changes in arousal and performance on cognitive tasks.<sup>22</sup>

Previously, it was believed that the impact of exercise intensity on cognition follows a U-shaped pattern, where moderate intensity improves cognitive function, but cognition declines at high intensity.<sup>23</sup> Contrary to the previous hypothesis, our recent research, along with other studies, does not support the idea of a U-shaped relationship between exercise intensity and cognition.<sup>20</sup>

In our study, high-intensity exercise improved selective attention compared to moderate exercise. This improvement in attention could be explained by psychophysiological mechanisms, including enhanced cerebral blood flow, which ensures an adequate supply of glucose and oxygen to the brain, and an overall improvement in psychological well-being.<sup>8</sup> It is further proposed that heightened levels of epinephrine and norepinephrine contribute to increased arousal, consequently leading to enhanced attention.<sup>24</sup>

## CONCLUSION

Our study confirmed previous findings and demonstrated that even a single session of 15 minutes of High-Intensity Interval Training (HIIT) enhances selective attention. Moreover, our results indicate that HIIT improved selective attention to a greater extent as compared to moderate exercise of the same duration.

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Following authors have made substantial contributions to the manuscript as under

Authors	Conceived & designed the analysis	Collected the data	Contributed data or analysis tools	Performed the analysis	Wrote the paper	Other contribution
Ahmad F	✓	✗	✓	✗	✓	✗
Zahra M	✓	✓	✗	✓	✓	✗
Zoofeen U	✗	✓	✗	✗	✓	✗
Shah Z	✓	✓	✓	✗	✓	✓
Mahmood A	✓	✗	✓	✗	✓	✗
Afridi A	✓	✓	✗	✓	✓	✗
Zulfiqar F	✗	✓	✗	✗	✓	✗

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

**Ethical Approval:**

**This Manuscript was approved by the Ethical Review Board of Khyber Girls Medical College, Peshawar. Vide No. 6065/PGMED/KGMC. Dated: 20 09 2020**



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