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Research Article

Physiological Effects of Single Bout of Moderate and High Intensity Interval Exercise on Selective Attention in Young Adults

Farida Ahmad[1]*, Musarrat Zahra[2], Zubia Shah[3], Fatma Zulfiqar[4], Afsheen Mahmood[5] and Fida Muhammad Zulfiqar[6]

[1]*Department of Medical Physiology, Khyber Girls Medical College, Peshawar, Pakistan*

[2]*Department of Physiology, Gajju Khan Medical College, Swabi, Pakistan*

[3]*MBBS, PhD Physiology, Institute of Basic Medical Sciences, Khyber Medical University, Peshawar, Pakistan.*

[4]*Department of Community Medicine, Khyber Girls Medical College, Peshawar, Pakistan*

[5]*Department of Physiology, Khyber Girls Medical College, Peshawar, Pakistan*

[6]*Clinical Pathologist, Khyber Girls Medical College, Peshawar, Pakistan*

***Corresponding Author:** Farida Ahmad, Department of Medical Physiology, Khyber Girls Medical College, Peshawar, Pakistan.

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Abstract

Objectives: The primary objective of the study was to determine the effect of moderate intensity exercise and high intensity interval exercise on selective attention.

Methodology: This experimental study was conducted at Khyber Girls Medical College Peshawar from September 2020 to February 2021. A total 34 young adults were recruited who were called for two experimental sessions. During 1st experimental session, participants performed moderate intensity exercise of 15 minutes. Forward digit span test were done both before and after exercise. They were then called after one week for 2nd experimental session. Same steps were carried out but this time they performed high intensity interval exercise. The High intensity interval exercise consisted of one minute of low intensity alternating with one minute of high intensity exercise.

Results: The mean age of participants was 20 ± 2 years, body mass index (BMI) was 23 ± 4 kg/m2 and mean waist hip ratio was 0.81 ± 0.05. After 15 minutes of high intensity interval exercise, selective attention was significantly improved (P = 0.001).

Conclusions: A single session of High intensity interval exercise was more effective at improving selective attention as compared to moderate exercise.

Keywords: High Intensity Interval Exercise; Selective Attention; Young Adults

Introduction

Physical exercise (PE) is defined as " a subset of physical activity that is planned, structured, and repetitive and has as a final or an intermediate objective of improving or maintaining physical fitness" [1]. There are different types of PE, exercise performed at 50-63%, 64-76% and 77-95% % of heart rate maximum (HR max) are termed low, moderate and high intensity exercises respectively. High intensity exercise has been further classified as continuous, high intensity interval training (HIIT) and sprint interval training [2]. HIIT is a type of exercise characterized by short bouts of high intensity exercise alternating with same duration of rest or lower level of physical exercise [2]. Though PE positively affects selective attention and subsequently memory but unfortunately most of our population is not sufficiently active. A World Health Organization survey shows that 23% of males and 32% of females worldwide do not engage in enough physical activity; only 5% of the adult population worldwide meets the basic recommendations of physical exercise [3]. The situation is even worse in Pakistan, 24.4% males and 43.3% females are not sufficiently active. They consider lack of time, use of internet, cell phones and computers as causes for non-compliance to exercise and sedentary behavior [4,5]. Luckily HIIT is less time consuming as compared to continuous moderate exercise and is preferred by most people [6-8]. It has recently emerged

as an effective exercise paradigm for brain health [9]. The main advantage of HIIT is that it provides strong stimulus for neuronal growth. HIIT is especially beneficial for controlling attention and filtering out unnecessary information when performing any cognitive task [10]. However there are few studies on the effects of HIIT on selective attention. The effects of HIIT on brain health still need to be explored [11,12]. Our study aims to add to the existing body of evidence by determining the effects of HIIT on selective attention in young adults.

Selective attention permits us to filter out insignificant information and focus on what matters. It also forms the basis for learning of complex material [13]. Unfortunately most of our young adults lose attention within 10 – 20 minutes after the start of a cognitive task [14]. The importance of phonological loop and attention in classroom teaching cannot be underestimated [15,16]. Moreover it is equally important etiological factor in patients with attention deficit disorders, obsessive compulsive disorders, Alzheimer's disease and Parkinson disease [17-19]. The amount of attention we pay to a task is controlled by central executive in the frontal lobe of the brain which also has the capability to access long term memory stores so by controlling attention one can enhance memory as well [20].

There are different ways to improve attention and subsequently memory for example environmental modifications, attention process training, self-regulatory strategies, use of external aids and psychosocial support in adults with attention deficit disorder [21]. In addition, physical exercise is known to improve attention both in healthy and attention deficit population [22,23].

Materials and Methods

This experimental study was carried at the Department of Physiology, Khyber Girls Medical College Peshawar. For the within subject design, sample size was calculated by power analysis and effect size based on previous results of Labban., *et al.* [24]. Power analysis was calculated by using effect size of 0.50. A sample of 34 participants was enough to get power of .80. After approval from ethical committee of Khyber medical university volunteers were recruited through personal contacts, notices and circulars. Young adult females age 18-25, were selected who had no history of psychiatric illnesses, psychiatric medications, smoking, neurological and musculoskeletal disorders. All of them fulfilled the exercise fitness criteria as assessed through physical activity readiness questionnaire [25].

After informed consent, anthropometric measurements of all the participants were taken such as weight, height, waist circumference and hip circumference. Low, Moderate and high intensity of exercise was determined for each individual according to their age. First Maximum heart rate (HR_{max}) was calculated for each individual by the formula 220-age [26]. Exercise performed at 50-63%, 64-76% and 77-95% % of HR_{max} was their low, moderate and high intensity levels respectively. High intensity interval exercise comprised of one-minute-high intensity exercise alternating with same duration low intensity exercise [2]. BMI was calculated by Quetelet' s formula (weight in Kg/height in meter square [27]. Adopting a within subject design, participants were asked to come for two experimental sessions. Participants were asked to refrain from tea and other caffeinated drinks 24 hours prior to experiment. On first experimental day pre exercise selective attention was assessed through Forward Digit span Test (FDST) which is used extensively throughout clinical and research studies and has high validity and reliability among healthy adults and is a subset of Wechsler's adult intelligent scale [28]. After this test participant were asked to perform 15 minutes of moderate exercise on tread mill (American Fitness, LK700T CORE) according to their individual levels calculated previously. We were closely monitoring the participants to keep their heart rate within the target ranges of moderate exercise. The subjects were assessed within 5 minutes of finishing exercise for selective attention again through digit span forward test. They were then called after one week for experimental session two. The same steps were carried out but this time they performed high intensity interval exercise for 15 minutes.

Results

The mean age for participants in years was 20 ± 1 SD, mean BMI 23 ± 4 (kg/m^2) and mean waist hip circumference ratio was 0.81 ± 0.05. The average Heart rate of the participants for moderate exercise was between 122 and 152 beats per minute, for high intensity most achieved heart rate of 153 to 190 beats per minute. Data was analyzed by SPSS version 20. Statistical significance was considered at $P < 0.05$. Shapiro wilk test was used to check the normality of data. Wilcoxon signed rank test for serum FDST showed a positive significant change $z = - 1.422$, $p = .15$ with a small effect size ($r = .1$) and $z = - 3.182$, $p = .001$ with a medium effect size ($r = .4$) for MIE and HIIE respectively.

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

Table 1: Forward Digit Span Test Scores After Exercise.

M1 before moderate exercise, M2 = after moderate exerciseH1 before high intensity interval exercise, H2 = after high intensity interval exercise, P < 0.05*, P < 0.01**.

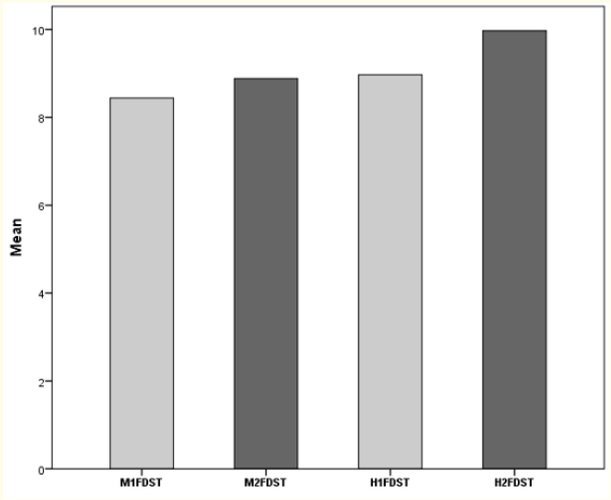

Figure 1: Forward Digit Span Test Scores before and after exercise.

FDST = Forward digit span test, M1=before moderate exercise, M2= after moderate exercise, H1= before high intensity interval exercise, H2 = after high intensity interval exercise.

Discussion

The objective of this study was to assess the effects of an acute HIT session on one aspect of cognitive function i.e., selective attention in young adults. We used digit span forward test (FDST) to assess selective attention. Moderate exercise did not affect attention while HIIT had a significant effect on selective attention. Mean forward digit span test scores before moderate exercise were 8.41 ± 2 and post exercise they were 8.86 ± 2 (P = 0.15). However HIIT had a significant effect on attention with mean FDST of 8.86 ± 1 and 9.86 ± 1 before and after exercise respectively (P = 0.001).

Results from previous research support our findings. There are several studies demonstrating a positive effect of HIIT on cognition and attention as measured by Victoria Stroop test, Reaction Time test and digit span tests [10,29,30]. Walsh., *et al.* 2018 recruited 22 university students, nineteen of the participants were females aged 20 ± 1 year. They were called for two sessions; a HIIT and control visit on separate days. The HIIE session lasted for 11 minutes. Participants completed the d2 test which is another test for measuring selective attention [31]. Effect size analysis revealed a moderate effect size of 0.459 in favor of HIIE with a P = 0.01 [32]. Our effect size was 0.486 and P = 0.001. Another study done at the university of Boston is also in line with our findings who checked inhibitory control, selective attention and declarative memory [10]. However Study by Alves., *et al.* 2014 does not match with our findings. They used both Stroop color word test FDST and concluded that HIIT improved the performance in Stroop color word test (P = 0.02) after performing 15 minutes of HIIT on cycle ergometer but no significant effect on FDST which may be attributed to the older age group that they recruited for their experiment i.e., 53 years [33].

Another study by Kao., *et al.* demonstrated that HIIT was more beneficial at inhibitory control as assessed by modified flanker task in young adult males and females [10]. A study carried out in children 8-10 years of age, also report significant effect after HIIE. Stroop performance was improved after one minute after (P < 0.01), and improvements were maintained until 30 min after exercise cessation [34].

Tsukamoto recruited 10 males and used felt arousal scale (FAS) to assess arousal level and color word Stroop task for measuring attention and found significant increase after HIIE [35].

Previously it was thought that intensity affects cognition in a U shaped manner, meaning that if we continue to increase the intensity of exercise from low to moderate, cognition will improve but after a high intensity is reached cognition will deteriorate [36]. On the contrary, our and other recent research do not support this hypothesis [33]. In our study the high intensity exercise improved selective attention as compared to moderate exercise. Possible explanation for improved attention can be attributed to psychophysiological mechanisms such as improved cerebral blood flow which provides brain sufficient amount of glucose and oxygen and improved psychological wellbeing [11,37].

It is also suggested that there is increased levels of epinephrine and nor epinephrine which leads to more arousal and subsequently increased attention [38]. Following exercise there is increased allocation of attention resources [32]. When a person is engaged in any information processing operations involving encoding and decision making he uses attention resources to complete this information processing. Human beings select a limited amount of sensory input to process the information while neglect other unrelated sensory inputs through attention resource allocation [39].

Conclusion

Our study validated the previous results and showed that even a single bout of 15 minutes of HIIT improves selective attention and it is more effective as compared to moderate exercise of same duration.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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