

## **Mindfulness Meditation Improves Athletes' Attention, Working Memory and Emotional State of Depression, Anxiety and Stress**

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### **Abstract**

Research on mindfulness meditation has been growing exponentially over the past three decades. The purpose of this present study is to investigate the effect of mindfulness meditation on attention, working memory, and emotional states of depression, anxiety and stress among athletes. Twenty male athletes from Sultan Idris Education University had participated in this study. Ten participants were randomly assigned into mindfulness group that received a mindfulness meditation audio and ten participants were assigned into control group that did not received mindfulness meditation audio. Neurosky Brainwave, N-back test, and DASS21 questionnaire were used to measure the attention, working memory respectively, and emotional state, respectively. Result from independence sample t-test showed that athletes in mindfulness meditation group significantly improved their attention ( $p=0.001$ ), working memory ( $p<0.001$ ), depression score in week 4 ( $p=0.006$ ), anxiety score in week 4 ( $p=0.001$ ), and stress score in week 3 ( $p=0.01$ ) and week 4 ( $p<0.001$ ), compared to control group. It was indicated from the findings that 4 weeks of daily mindfulness meditation is beneficial for the athletes to have better attention, good working memory, as well as a better control of emotions.

**Keywords:** Athlete, Attention, Emotion, Mindfulness, Working Memory.

### **1. INTRODUCTION**

For over a thousand years, mindfulness meditation has been around and has been used to improve focus and to treat psychological problems. Mindfulness is a process that takes the

individual's focus entirely on the feelings and thoughts experienced from time to time. Mindfulness is produced through focus attention techniques performed on purpose, without the presence of self-assessment elements.<sup>1,2</sup>

Through mindfulness, the individual seems to "do nothing" to the feelings and thoughts experienced.<sup>1</sup> Research shows that mindfulness training can reduce stress,<sup>3,4</sup> improve the level of well-being<sup>5</sup> and physical health.<sup>6</sup> Prazak and colleagues found that individuals with high levels of mindfulness demonstrate better cardiovascular health and psychological status.<sup>7</sup> Mindfulness techniques can also encourage athletes to be more open, willing and aware of personal change through regular exercise.<sup>1</sup>

Mindfulness meditation has been contributed a lot in sport performance. Baer defined mindfulness meditation as "the intentional self-regulation of attention from moment to moment".<sup>8</sup> The result of previous research found that mindfulness meditation also help athlete to improve their attention. Mardon, Richards and Martindale said in their research that "athletes who underwent mindfulness training would experience increased mindfulness, increased attention efficiency, improved performance times, and improved self- and coach-rated performance evaluations".<sup>9</sup> According to Moore and Malinowski, an important mechanism in improving athlete performance especially the athlete attention are through mindfulness meditation training.<sup>10</sup>

Based on previous research, it is possible that mindfulness meditation can help reduce negative emotion such as stress. Emotion regulation is very important for every athlete to achieve their optimal performance in sports. People that practicing mindfulness meditation will be able to develop a better ability to blank out distracting emotional stimuli and fully focus on the task that are given. Previous research also found that mindfulness meditation training acted as a stress buffer.<sup>11</sup> Therefore, mindfulness meditation has its own beneficial effect on various measures of stress.

Mindfulness meditation training not just involved self-regulation of attention, but also involved in measureable improvement in memory processes. Previous research found that mindfulness meditation not only increase one's attention, but also improved working memory capacity.<sup>12,13</sup> A recent study revealed that four weeks of mindfulness training able to protect against proactive interference and increases the volume of the left hippocampus.<sup>14</sup> Interestingly, a study showed even with a brief 3-minutes mindfulness exercise can have immediate improvement on recognition memory performance.<sup>15</sup>

The development of sports in Malaysia today is in line with progress and the rapidity and influence of sports from other countries. Although the study of mindfulness meditation has long been carried out and proven to increase athletic attention, emotion, and memory, the technique is less practiced by coaches and athletes in Malaysia. Therefore, this research was to expose the effect of mindfulness meditation on attention, emotion, and memory among athletes

## **2. METHODS**

### **2.1 Participants**

The participants of this research study consisted of twenty male athletes, aged from 20-23 years old (mean age: 21.5 years old, SD: 1.29) from Sultan Idris Education University. The athletes came from different sport such as taekwondo, football player, badminton, track and field and kayaking. None of the participants in the experiment had practiced meditation of any kind prior to the experiment.

### **2.2 Procedure**

On the first day of meeting, the researcher handed out informed consent form to the participants to be filled by them. Then the research objective, nature of mindfulness practice and experiment's procedure was explained to the participants followed by randomly assigned into either the mindfulness group (n=10) or the control group (n=10).

Then participants were asked to take attention test and memory test as a pre-test data. The attention test was conducted in a quiet room, using NeuroSky Mindwave (NeuroSky Inc., USA). The N-back test was used to test the memory of the participants in this study, and it was accessed through the website <http://cognitivefun.net>. In the N-back test, the participant is presented with a sequence of picture, and the task consists of indicating when the current picture matches the one from  $n$  steps earlier in the sequence. When all participant finished completing the attention and memory test, the researcher give a meditation audio to the mindfulness group. The mindfulness group were asked to listen to the mindfulness meditation audio and doing mindfulness meditation every 5 minutes before going to bed.

Depression Anxiety Stress Scales (DASS) were given to all the participants to be filled once a week in four weeks to measure their psychological symptoms. After four weeks of mindfulness meditation training, all the participants were asked to take attention test and memory test using Neurosky Brainwave and Cognitive Fun for the last time as post-test data.

### **2.3 Data Analysis**

All data are expressed as mean  $\pm$  S.D. The significance differences between groups on attention and memory was determined using independence sample t-test and was performed using SPSS 22.0 (SPSS Inc., Chicago, IL, USA). Meanwhile Microsoft Excel 2013 was used to determined significance differences between groups on emotion.

## **3. RESULT AND DISCUSSION**

### **3.1 Effect of mindfulness meditation on attention**

Mindfulness training in sport has attracted much interest due to the significant benefits it causes on athlete's performance<sup>16,17</sup> and well-being.<sup>18</sup> In the present study, there was significant difference ( $p=0.001$ ) showed on athletes' attention after 4 weeks of mindfulness meditation training ( $45.52\pm 6.78$ ), which represent 49% of improvement compared to control group ( $89.23\pm 10.59$ ) (Figure 1). Athletes in mindfulness group also significantly improved their attention by 48% ( $p<0.001$ ) in their post-test as compared to the pre-test data ( $88.0\pm 5.04$ ). Meanwhile, no significant improvement on attention was shown among the athletes in control group.

These findings are in agreement with previous reports which also obtained meditation-related attention improvement, especially in the area of conflict monitoring, through tasks such as the attention network test and the attentional blink test.<sup>19,20</sup> Electrophysiological studies suggest that meditation may be enhancing attention through neural mechanisms involving the error-related negativity signal, an event related potential that signals error detection and is associated with the anterior cingulate cortex and dorsolateral prefrontal cortex.<sup>21</sup> Other studies suggest that the improvements in attention, working memory and recognition memory performance observed here may be mediated at least in part by changes in resting state brain activity. For example, a number of studies have reported that a long-term meditation practice enhances resting state alpha and theta power.<sup>22,23</sup> These oscillatory brain states have been linked to both relaxation as well as cognitive functions, including attention, information processing, and learning and memory; collectively, enhancements in alpha and theta may lead to the "relaxed alertness" experienced after a meditation practice.

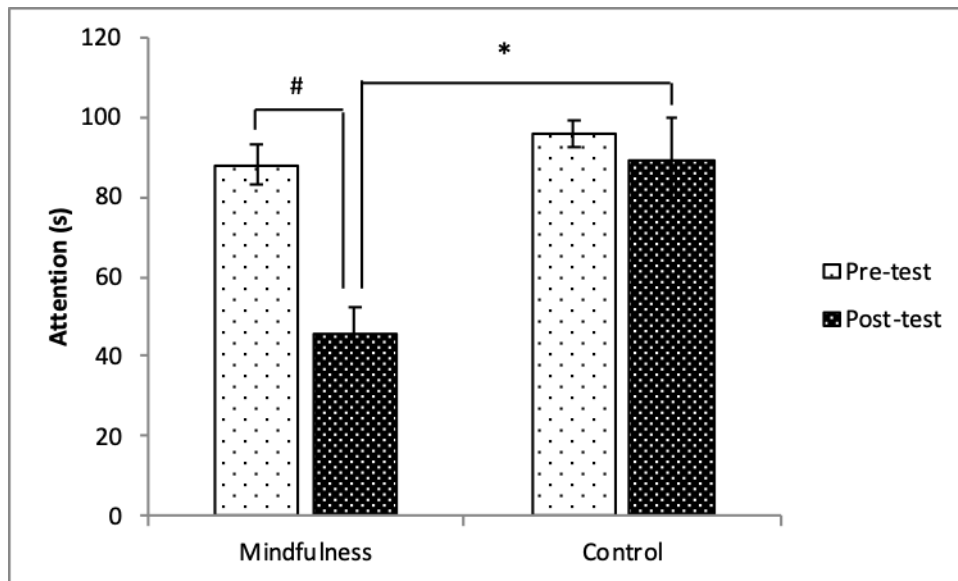


Figure 1: Performance on attention. Lower score denote greater performance. Data are expressed as mean  $\pm$  SE. # $p < 0.05$  vs pre-test (within group); \* $p < 0.05$  vs control post-test (between group).

### 3.2 Effect of mindfulness meditation on working memory

Working memory is fundamental in the improvement of attentional control, and mindfulness training has been proved to correlate with the greater working memory.<sup>13,24</sup> In this study, the athletes' working memory were tested using N-back test, and evaluated based on the percentage of error and reaction time. Based on Figure 2, the athletes in mindfulness group showed significant improvement by showing 35% reduction of the percentage of error ( $p < 0.001$ ) in post-test ( $49.81 \pm 3.68$ ) as compared to pre-test data ( $76.29 \pm 2.35$ ). Their post-test data also showed 37% improvement ( $p < 0.001$ ) compared to control group ( $79.08 \pm 2.09$ ). However, no significant changes on reaction time were seen among meditation (pre-test  $0.92 \pm 0.06$ s; post-test  $0.93 \pm 0.03$ s) and control group (pre-test  $0.71 \pm 0.05$ s; post-test  $1.02 \pm 0.14$ s).

Consistent with this findings, previous studies have reported that meditation enhances performance on the N-back task.<sup>25,26</sup> For instance, Mrazek and colleagues tested 2 weeks of mindfulness training in reducing mind wandering during Graduate Record Examination, and they found an improvement on reading-comprehension scores and working memory capacity while a reduction in the occurrence of distracting thoughts during completion of the exam.<sup>27</sup> Increased levels of grey matter volume in the frontal cortex, especially in the areas of the anterior cingulate cortex and medial frontal gyrus might be a possible morphological

correlate of these working memory improvements.<sup>28</sup> Additionally, mindfulness meditation training also was found to be associated with the increase of hippocampal volume through interference reduction.<sup>14</sup>

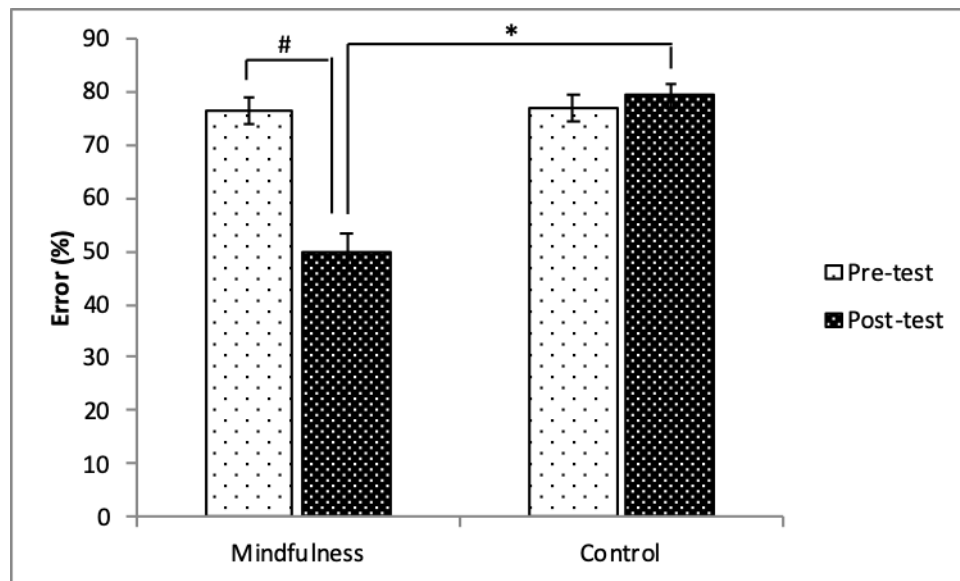


Figure 2: N-back test performance for percentage of error. Lower score denote greater performance. Values are expressed as mean  $\pm$  SE, # $p < 0.05$  vs pre-test (within group); \* $p < 0.05$  vs control post-test (between group).

### 3.3 Effect of mindfulness meditation on emotional states of depression, anxiety and stress

As presented in Figure 3, the depression score for the athletes in mindfulness group was significantly reduced ( $p = 0.034$ ) in week 4 ( $2.5 \pm 0.43$ ) as compared to week 1 ( $3.9 \pm 0.71$ ), by 36%. The week-4 data for mindfulness group also showed 52% reduction ( $p = 0.006$ ) compared to control group ( $5.2 \pm 0.74$ ). The depression score among athletes in control group did not significantly differ from week 1 until week 4.

Whereas, as shown in Figure 4, the anxiety score among athletes in mindfulness group reduced significantly in week 3 ( $p = 0.001$ ,  $6.4 \pm 0.83$ , 25% reduction) and week 4 ( $p < 0.001$ ,  $4.3 \pm 0.67$ , 50% reduction) compared to week 1 ( $8.6 \pm 1.14$ ). When compare to control group ( $7.9 \pm 0.87$ ), the significant different ( $p = 0.001$ ) was only seen in week 4, where the data showed 45% of reduction in anxiety score. No significant changes on anxiety score were seen among athletes in control group from week 1 until week 4.

The stress score among athletes in mindfulness group showed significant reduction in week 3 ( $p=0.008$ ,  $5.3\pm 0.37$ ) and week 4 ( $p<0.001$ ,  $3.6\pm 0.45$ ), compared to week 1 ( $7.0\pm 0.67$ ) (Figure 5). Those data were also significantly different (week 3,  $p=0.01$ ; week 4,  $p<0.001$ ) compared to the respective weeks in control group (week 3,  $7.4\pm 0.63$ ; week 4,  $7.4\pm 0.65$ ). The 4-weeks stress score among the athletes in control group were not significantly different from each week.

Previous research in this area has shown an association between self-reported mindfulness and affective state.<sup>29</sup> Specifically, high levels of mindfulness are associated with high levels of positive affect and low levels of negative affect, perceived stress, and depressive symptom severity. One randomized controlled trial study found that 8 weeks of Mindfulness-Based Stress Reduction training reduced perceived stress and vital exhaustion while enhancing positive affect, quality of life, and mindfulness.<sup>30</sup> Interestingly, a proclaimed made by basketball players who meditated, that sitting down and freeing their mind helped them discover who they really are and see things in a different light. The players also stated that they were able to feel less stress, worry, social insecurity, feelings of fear and anger.<sup>31</sup>

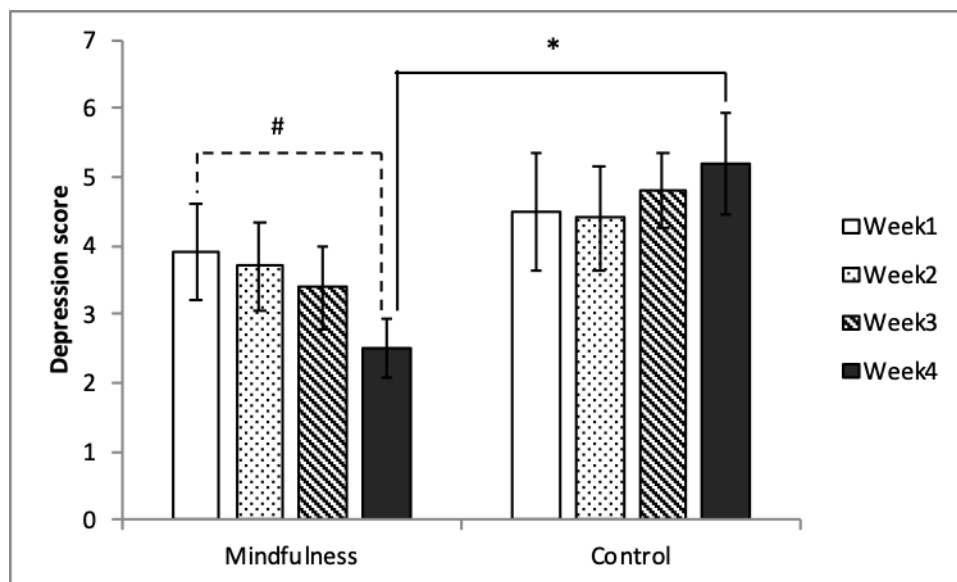


Figure 3: Depression score. Values are expressed as mean  $\pm$  SE, # $p<0.05$  significant difference within group (comparison with week 1); \* $p<0.05$  significant different between group (comparison between each particular week).

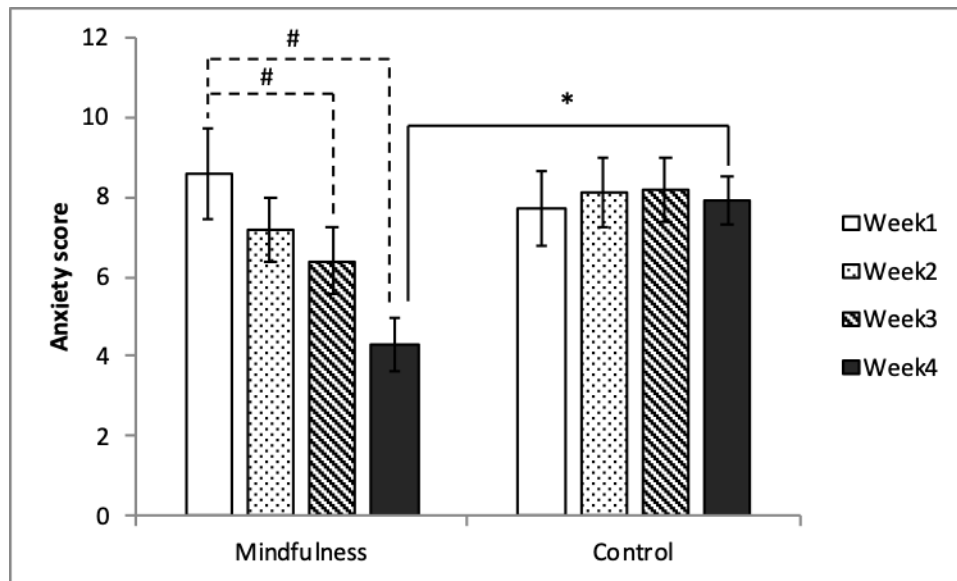


Figure 4: Anxiety score. Values are expressed as mean  $\pm$  SE, # $p < 0.05$  significant difference within group (comparison with week 1); \* $p < 0.05$  significant different between group (comparison between each particular week).

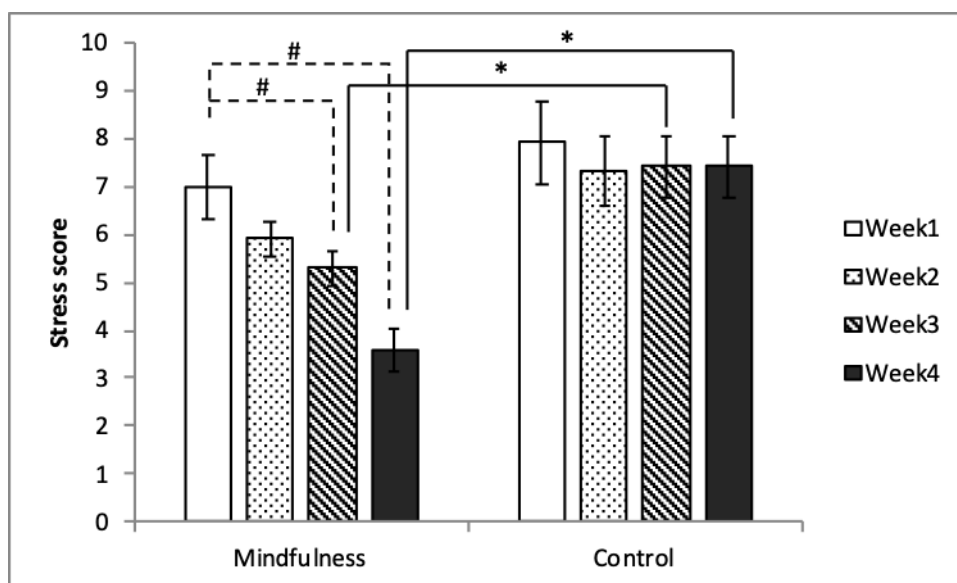


Figure 5: Stress score. Values are expressed as mean  $\pm$  SE, # $p < 0.05$  significant difference within group (comparison with week 1); \* $p < 0.05$  significant different between group (comparison between each particular week).

In conclusion, this study proved that the mindfulness meditation training helps the athlete to reduce their negative emotion. Mindfulness meditation also helps athletes to improve their attention and memory. Although there is some research found, it is recommended that more extensive studies be done because it is still only an emerging field of study within the last 20



years. 4-weeks of brief daily meditation are beneficial not only for decreasing negative mood state but for stress reduction, as well as the ability to pay attention to and remember information in the environment. For recommendation for future studies, researchers should increase the sample size and the duration of mindfulness meditation therapy.

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