# The Effect of Mindfulness Meditation on HPA-Axis in Pre-Competition Stress in Sports Performance of Elite Shooters

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**Abstracts**: Background: Little has been known about the Hypothalamic Pituitary Adrenal (HPA) axis response to pre-competition stress (PCS) and its response to relaxation therapies such as of Mindfulness Meditation Therapy (MMT) on sports population. In shooting sports good physical as well as psychological condition is highly demanded. Researchers have been performed on the psychophysiological responses of MMT on normal and diseased persons, but little has been done on sports population especially in shooters. Objective: The purpose of current study was to estimate the contribution of MMT on Salivary Cortisol (SC), a reliable physiological marker of HPA- axis response in reducing PCS, and its effect on shooting performance (PS). Methods: 96 male elite Shooters, with mean age of 29.5±4.3years were examined as in experimental and control (48 in each). Total duration of the study was five weeks, four weeks of experimental and one week study to determine the follow-up effect. Pre, post and follow-up data of quantitative phenotypic markers of HPA-Axis activity by analysis of SC and PS were analyzed. Results: Compare to control, experimental group has shown significant result, post-intervention ($p<0.001$) and in follow-up ($p<0.001$) in SC and in PS. Resulted in reduction of PCS level and increase in PS, whereas the control group has been shown non-significant result ($p<0.05$).Conclusions: Results indicated that relaxation therapies such as MMT may decrease PCS and will enhance PS. It is concluded that in four weeks of MMT has an effect on HPA-Axis by decreasing the level of SC as a reliable physiological marker of PCS. [ John S NJIRM 2011; 2(3) : 15-21]

**Key Words**: HPA, Cortisol, Pre competition Stress, Meditation, Shooting.

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**Introduction:** Air pistol shooting is an Olympic sport requiring extreme mental concentration and movement precision for success. Pistol shooting is a static activity requiring a strict control of body segments and posture to align the rear sight aperture and the foresight through proprioceptive feedback and gaze fixation either on the target directly or between the target and the weapon and, therefore, to increase precision of the shot[1]. Compared to that for rifle shooting, there is very little literature related to pistol shooting. In this work, we investigated pistol shooting.

Stress is most often used to describe an unpleasant emotional state or condition which is characterized by subjective feelings of tension, apprehension, and worry. In sports context it is commonly known as pre-competition stress or anxiety. Further, research indicated that anxiety has a negative effect on these sport outcomes[2]. Research findings suggest that, prior to competing; sport performers encounter more stressors pertinent to performance[3]. These observations highlight that all the demands faced by athletes should be considered when preparing and implementing interventions to manage competition stress. Pre-competition anxiety is a widely prevalent condition that exists among athletes of all levels and within every sport[4,5,6]. Despite the large body of research on pre-competition anxiety, our understanding of its relationship to performance remains elusive.

Cortisol is a hormonal response to acute stress and has been measured to be higher before competition than at resting conditions[7]. Some researchers have found that athletes produce higher levels of Cortisol before games than before non-competition situations[8,9,10,7]. The results support previous findings that athletes are more anxious before games than during off days[11]. Research findings comparing the physiological and psychological markers of stress have been equivocal[9].

Relaxation techniques have been used in sports primarily to enhance recovery from training and competition, manage anxiety and improve performance[12]. The techniques of mindfulness meditation which focus on awareness to develop a detached observation of the contents of consciousness may represent a powerful cognitive behavioural coping strategy for transforming the ways in which we respond to life events[13]. Even though many studies on MMT have been criticized for the lack of scientific rigor, including the lack of high quality randomized controlled studies designed to differentiate between the specific (i.e. specifically related to repeated sitting meditation practice) and the non specific (i.e. related to benefits' expectations) effects of such practices[14], and the frequent use of self report instruments as measures of clinical improvements following MMT[15].

The present study focused on examining the relation of physiological response to skilled sport performance, and investigating the relevance of MMT in pre-competition anxiety. For this purpose, Salivary Cortisol (SC) were recorded during the training and pre-competition phase of actual shooting.

**Material and Methods:** Subjects: A total of 110 healthy male elite level shooters with mean age of (29.5±4.3years) selected for the study. Subjects were voluntarily recruited from national shooting team; permission was obtained from officials. Questionnaires administered prior to the experiment were indicated that no volunteers are included as per exclusion criteria such as any physical or mental illness, hearing impairment, and have been undergoing meditation therapies for last 3 months. All subjects were nonsmokers, medication-free and not habitual drinkers. The aims of the present study, the procedures involved and potential risks of the study were explained carefully to subjects, and the written consent was obtained prior to the study. The study and all protocols were approved by research ethical committee of Punjabi University.

Participants were randomly allocated into two groups; experimental (MMT) and Control by multiple blocked random sampling of 55 in each group, after the dropout 96 subjects could complete the study in each group. The baseline values of Heart Rate (70±3bpm), Respiratory Rate (15±2rpm), BMI (24±1.04kg/cm$^2$) and Blood Pressure (119±4/79±4 mm of Hg) were documented. For the better understanding of Interventions a sample trial was conducted to the experimental subjects one week prior to the study. Concerning impediments to effective practice, subjects were monitored by the researcher and experts during the interventions. The intervention was provided over the course of four weeks and one week follow-up, group sessions with a maximum of 8 participants each, 20 minutes session per day, 6 days a week and one day was off per week. Participants were asked not to consume caffeine or alcoholic beverages for 12 h, and not to exercise for 12 h prior to the experiment especially during testing.

Procedure: The all participants of each batch reported to the laboratory at 08:00AM, each session conducted in the morning (between 8 AM and 10 AM) and The subject changed into loose fitting clothing, and shoes removed then the participants were instructed to lie in the supine position on the floor mat in a quiet, light-attenuated electrically shielded room with the temperature between 24 and 28 °C with their eyes closed.

Interventions; Mindfulness Meditation Therapy (MMT): The first step in performing a MMT is to adopt a posture that ensures an erect spine and shoulder resting on the mat, with the hands should be placed on the upper position of the abdomen, the position of head kept slightly foreword with the support of small towel roll. The eyes may be fully closed, or the upper lids may be dropped and was given 1 minutes of adaptation period. As a meditation condition progress, subjects were asked to undergo 3 minutes for stabilization by Shavasana, For Shavasana training the technique recommended by Coulter was used[28]. The subject was asked to relax , after this, they performed meditation comprising a Pranayam for 4 min while situated as in the control condition (in the supine position with the eyes closed and respiration at a constant frequency of 0.2 Hz in tempo with the sound of a metronome (i.e., 5 breaths/min for 4

min)). Then the participants were instructed mindfulness by body scan i.e. focusing attention on various joints of body by focuses on the each joint from proximal to distal as described and feels without labeling the sensations as either "good" or "bad" in a sequence from distal to proximal. Once they completes again for 4 minutes Pranayam at a constant frequency of 0.2 Hz in tempo with the sound of a metronome and ended with 3 minutes of Shavasana. Subjects were informed to raise their hands during any discomfort while doing meditation and if so they were asked to immediately stop the session. Subsequently, the participants left the room after 20 minutes of session.

Testing; The testing sessions were conducted between 8 am and 10 am and the same researcher tested all subjects. Measurement day scheduled one day prior to beginning the 1st week, 29th day and 36th day, subjects were assessed for pre-test, post-test and follow-up data respectively, except Performance Test, in a quiet controlled room with ambient temperature (24–28$^0$C). The performance score calculated by pre-scheduled a competition in a internationally standard shooting range on one day prior to beginning the 1st week, and on 29th day, subjects were assessed for pre-test, post-test Performance score respectively.

All Participants were instructed to avoid consuming stimulant beverages, tea, and coffee; exercising, in the 12 hours previous to the examination. The all participants of each batch reported to the laboratory at 08:00AM, measurement procedure started between 09:00 am and 10:00 am, to control as much as possible for time of day, to avoid circadian variations. Prior to testing, Participants attended a detailed briefing session where they received full verbal instructions regarding the procedures of the study. SC samples were taken been 9:00 am -10:00 am to minimize time of day effects. All subjects were tested individually.

Salivary Cortisol; For obtaining the free, unbound, biologically active moiety of cortisol, saliva samples were collected. To rid the mouth of contaminates, subjects rinsed thoroughly with water ten minutes before saliva collection. Subjects sat unrestrained in a comfortable chair with lumbar support, Subjects were then allowed to relax for five minutes, the experimenter then began each test session and collected minimum of 2 ml of saliva by tilting the head forward, allowing the saliva to pool on the floor of the mouth, then passing the saliva through a short straw into a polypropylene vial. The Salivary samples were labeled and sealed and refrigerated in an ice box within 30 minutes. After all procedures the sealed sample sends to the laboratory on the same day by 2:00 h to store under-15 degree centigrade to the laboratory for later analysis,

Free cortisol level data from the samples of saliva were analyzed in the laboratory by using Salimetric$^{sTM}$ salivary cortisol kit. On day of assay, samples brought at room temperature and thaw completely, vortex, and centrifuge at 1500 x g (@3000 rpm) for15 minutes before adding to assay plate and cortisol was assessed in via enzyme-linked immunosorbent assay as per manufacturer (Salimetrics$^{TM}$) instructions.

Performance score; Measure of shooting accuracy or shooting score was calculated from the standard shooting scoring board and the final result of competition obtained from the chief coach after the completion of competition, in order to test shooting performance.

**Result:** Descriptive statistics of study and outcome variables measured in 48 subjects each in experimental and control group. The comparison of base line mean values of study variables (Table-1) and outcome variables (Table-2 ) among the 2 study groups, that is male shooters who had interventions: as MMT and control, shows a non statistically significant difference in the mean values of Age( F= 1.15; p= 0.332), BMI (F= 3.57; p=0.015), heart rate (HR)( F= 0.10;p=0.961), respiratory rate (RR)(F=2.44;p=0.066), diastolic blood pressure (BPD)(F=0.42;p=0.736), and systolic blood pressure (BPS) (F=1.11;p=0.347) and SC(F= 0.02; p = 0.995),,PS (F= 0.40; p = 0.756).

In MMT group, the mean values of Salivary Cortisol (SC) had statistically significantly decreased from the baseline value of 1.33 to 0.66 at 29th day and 0.93 at 36th day which is statistically significant

(F=834.6;p<0.001).The post hoc pair wise comparison of these values indicates highly statistically significant difference among the values. From this it can be infer that the effect of meditation in this group has decreased the SC values significantly from their base line values. The mean value of performance score has statistically significantly increased from 528 to 544(t-value=-6.85, p<0.001) (Graph-1).

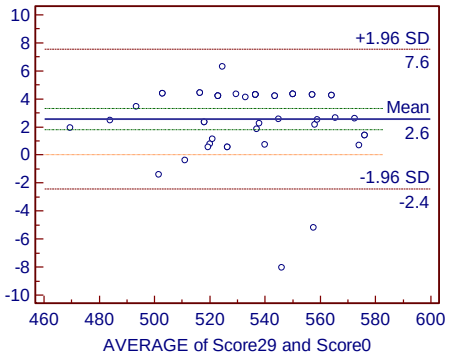
**Table:1 Mean values of Study variables in comparison between MMT and Control groups**

| Study Variables | MMT | | Control | |
|---|---|---|---|---|
| | Mean | ±SD | Mean | ±SD |
| Age | 29.40 | 4.08 | 30.2 | 4.68 |
| BMI | 24 | .8 | 24 | 1 |
| HR | 70 | 6 | 70 | 4 |
| RR | 15 | 2 | 16 | 2 |
| BPD | 119 | 6 | 119 | 3 |
| BPS | 79 | 5 | 80 | 3 |

**Table:2 : Comparison of mean values of outcome variables at 3 stages in male shooters of study**

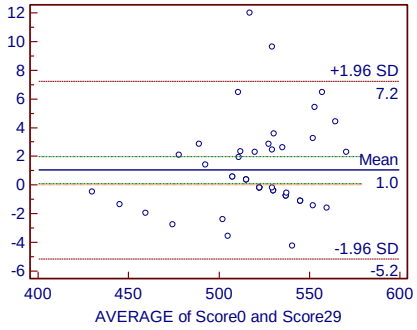
| Outcome Variable | MM T Group | | Control Group | |
|---|---|---|---|---|
| | Mean | ±SD | Mean | ±SD |
| SC-0Day | 1.33 | 0.06 | 1.33 | 0.06 |
| SC-29th Day | 0.66 | 0.07 | 1.95 | 0.08 |
| SC-36th Day | 0.93 | 0.11 | 1.6 | 0.11 |
| PS-0Day | 528 | 13 | 524 | 2 |
| PS-29th Day | 542 | 13 | 518 | 16 |

**Graph- 1: Bland and Altman plot—Comparison of pre and post performance values of study subjects who had meditation as intervention**




In control group, the mean values of Salivary Cortisol (SC) had statistically significantly increased from the baseline value of 1.33 to 1.95 at 29th day and 1.60 at 36th day which is statistically significant (F=577.48;p<0.001).The post hoc pair wise comparison of values indicates highly statistically significant difference among the values. From this it can be infer that the effect of no meditation intervention in this group has increased the SC values significantly from their base line values. The mean value of performance score has statistically significantly decreased from 524 to 522 (t-value=0.65, p<0.001)(Graph-2).

**Graph-2: Bland and Altman plot—Comparison of pre and post performance values of study subjects who had no intervention**




**Discussion:** In the current study, used Salivary Cortisol (SC) as physiological marker and Performance Score (PS) as subjective marker to assess the changes in groups. These parameters are very much reliable to provide true picture of changes and also susceptible for changes in pre competition anxiety or stress. This fact is supported by[8,10] and also supported by research findings comparing the physiological and psychological markers of stress have been equivocal[9]. Since the salivary cortisol assay has been proposed as the method of choice for assessing adrenocortical (endocrine) function. Thus in this study included SC as a physiological marker.

The result of the study indicated that there is an increase in post intervention and follow up values in MMT group whereas the control group, it was highly insignificant result. In MMT group, the cortisol level in saliva decreased in post-intervention and follow up. i.e. 50% (.66) and as follow up carry over decrease of 20% (.93). Whereas control group showed an increase of 47% (1.95) and 26% (1.60) pre-competition and post

competition respectively. In performance score experimental group showed an increase of 2.6% (542) from base line (528), whereas control group showed decrease of 0.9% (518) from base line (524). The reason for these changes supported by studies on competition stress, supported that, prior to competing, sport performers encounter more stressors pertinent to performance[3]. The level of anxiety automatically narrows perception restricting the focus of attention[16,17,18,19]. Thus result of this study indicated that there is an decrease in control group and increase in post intervention performance score in all interventional groups; the reason for these changes might be due to decrease in pre competition anxiety.

Cortisol is a hormonal response to acute stress and has been measured to be higher before competition than at resting conditions[7]. In recent years, however, salivary cortisol has been shown to reliably reflect levels of unbound cortisol in the blood and raised levels have been found to be associated with stress in normal subjects[20]. Based on these facts if any intervention is effective to reduce competition stress then we observed the reversibility in behaviour of this marker. These observations highlight that all the demands faced by athletes should be considered when preparing and implementing interventions to manage competition stress.

Meditation has been shown to decrease cortisol levels in populations of healthy volunteers[21] , but the effect of meditation training program in pre competition stress and release of cortisol levels has not previously been evaluated in Sports population. However, there has been some investigation of the effects of psychosocial intervention on cortisol levels in normal and patient population. Study supported by participants who meditated had better attentional processing on alerting function as well as better mood, lower cortisol, and better immune function, allowing to conclude that randomly assigned short-term intensive meditation causes immediate benefits. *This* might have improved performance[22].

Result of the current study showed intervention group has been shown some amount of follow up effects even after one week of intervention this is supported by studies such as, found evidence that post meditation there was significant competitive performance improvements, and these improvements were maintained at 6-month follow-up[23].

**Conclusion:** The past empirical evidence has lent support to the view that psychophysiological recordings may even provide insight into the skill related aspects of a shooter's psychomotor strategies and determinants of successful shooting performance. Results of this study showed positive correlation in MMT than controlled group in one month duration training. It has shown improvement in dependent variables such as decrease salivary cortisol and Performance score of individual shooter. As previous studies the long term training may enhance the further in experimental group. It is suggested that the intensity of improvement and follow-up effect shall be analyzed and compared in long duration interventional training i.e. more than a month. To our knowledge until HPA- Axis has been little evaluated in young athletes, especially in such conditions of pre-competitive stress and efficacy of post relaxation therapies. This work was made possible to find out the changes on the endocrine (HPA axis) activity during intervention, or changes induced in pre-competition stress. Although short-term activations of the HPA axis are adaptive and necessary for everyday functioning, extreme, frequent or chronic activation of this system are associated with negative health outcomes. Existing research has implicated the HPA axis in the development of a variety of sub-clinical and clinical conditions including metabolic syndrome[24], depression[25], risk for cardiovascular disease26 and cognitive decline[27].

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