The Effect of Music Therapy on Salivary Cortisol as a Reliable Marker of Pre Competition Stress in Shooting Performance

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Abstract

Studies have been performed on the psychophysiological responses of Music Therapy (MT) in normal and diseased, but little has been done on pre-competition stress (PCS) and Hypothalamic Pituitary Adrenal (HPA) axis response on sports population. The purpose of the current study was to estimate the contribution of MT on Salivary Cortisol (SC) in reducing PCS, and its effect on shooting performance (PS). One hundred male shooters between the age range of 29.5±4.3years were examined as experimental (N=50, MT along with the routine sports specific training) and control (N=50, only with the routine sports specific training). Duration of the study was 5 weeks, 4 weeks of interventional and 1 week study to determine the follow-up effect. Pre, post and follow-up data of quantitative phenotypic markers of HPA-Axis by SC and PS were analyzed. Compared to the control, experimental group has shown significant result, post-intervention ($p<0.001$) and in follow-up ($p<0.001$) in SC and in PS. Experimental group demonstrated in reduction of PCS level and increase in PS, whereas the control group showed non-significant result. Results indicated that relaxation therapies such as MT may decrease PCS and therefore enhance PS. It is concluded that four weeks of MT has an effect on HPA-Axis by decreasing the level of SC as a reliable physiological marker of PCS.

Key Words: HPA, Cortisol, Pre competition Stress, Music, Shooting.

Introduction

In shooting the requirement of good physical and psychological condition as well as technical perfection is highly demanded *(Antal et al., 1994).* 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 *(Mononen et al., 2007).* Air pistol shooting is an Olympic sport requiring extreme mental concentration and movement precision for success. Compared to that for rifle shooting, there is very little literature related to pistol shooting. To our knowledge, this is the first study to determine the efficacy of Music Therapy (MT) on Salivary Cortisol (SC) in professional shooters. 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, researches indicate that anxiety has a negative effect on these sport outcomes *(Terry & Slade, 1995).* Research on how athletes cope with sport-related stress has been recognized for both its practical and its theoretical importance because of the debilitating effects that stress may have on athletic performance *(Smith et al., 1998). F*indings of *Mellalieu et al (2009)*

suggest that, prior to competing; sport performers encounter more stressors pertinent to performance. These observations highlight that all the demands faced by the 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. Its relationship to performance has been studied both in and out of the sport context through test anxiety research *(Liebert & Morris, 1967)* and anxiety research with athletes *(Swain & Jones, 1996; Kais & Raudsepp, 2005; Chamberlain & Hale, 2007).* 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 *(Salvador et al., 2003).* Some researchers have found that athletes produce higher levels of cortisol before games than before non-competition situations *(Salvador et al., 2003; Filaire et al., 2007; Haneishi et al.,2007).* The results support previous findings of *Filaire et al (2009)* that athletes are more anxious before games than during off days. Because cortisol is secreted as a result of a threatening stimulus, and sports competition is considered an anxiety-arousing situation *(Salvador et al., 2003).* Research findings comparing the physiological and psychological markers of stress have been equivocal *(Filaire et al., 2001).*

Applied sport psychology, in its efforts to enhance the competitive performance of athletes, has traditionally utilized cognitive behavioral methods and techniques with an emphasis on developing self-control of internal states, commonly referred to as psychological skills training *(Whelan et al., 1991).* Relaxation techniques have been used in sports primarily to enhance recovery from training and competition, manage anxiety and improve performance *(Solberg et al., 2000).* One mechanism through which music may impact on flow is by enhancing pre-performance mood. Indeed, in a recent review, presented a strong case for the mood-enhancing effects of music in a sport context. *(Vlachopoulos et al., 2000).* Studies support previous research that found music to be an effective tool for improving athletic performance *(Karageorghis et al., 1996).*

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

Materials and Methods

Subjects: A total of 110 healthy male elite level shooters aged (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 under going music 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 (Music Therapy) and Control by multiple blocked random sampling of 55 in each group, after the dropout 100 (50±3) subjects could complete the study in each group. 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 recruited to participate in this study. Intervention 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:

Music Therapy: CD of 30-40 music of Raga Darbari based Hindi songs given to the experimental subjects one week prior to the study and asked them to select 5-10 songs according to their choice from the songs given, after selection of individual choice of music made separate folder for each subjects. The music was delivered on Sony^{TM} MP3 player by headphone with volume of 60-70 dB, 60 to 70 beats per minute.

The music therapy group was encouraged to assume a comfortable position in supine position on a floor mat during delivery of the music intervention, Advised subjects to clear their minds and allow their muscles to relax throughout the training session. The participants left the room after 20 minutes of session. Experimental group underwent music therapy along with the routine sports specific training and control group only with the routine sports specific training.

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 the participants were instructed to avoid consuming stimulant beverages, tea, and coffee; exercising, in the 12 hours previous to the examination. All the 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. Salivary Cortisol 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 labelled 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) for 15 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.

Results

Table: 1 Comparison of mean values of study variables in male shooters of study groups

Study Variable	Music Therapy		Control Group	
	Mean	± SD	Mean	± SD
Age	28.67	4.24	30.2	4.68
BMI	24.27	1.11	23.8	1
HR	69.54	4.14	70.02	4.12
RR	15.46	1.73	15.61	1.58
BPD	119.42	4.38	119.41	3.2
BPS	78.58	3.92	79.93	3.3

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

Outcome Variable	Music Therapy		Control Group	
	Mean	± SD	Mean	± SD
SC-0Day	1.33	0.06	1.33	0.06
SC-29th Day	0.53	0.07	1.95	0.08
SC-36th Day	0.91	0.11	1.6	0.11
PS-0Day	528	29	544	30
PS-29th Day	522	31	518	28

Table: 3 Comparison of mean values of outcome variables at 3 stages in male shooters of study groups (One way Analysis of Variance)

	Sum of Squares	df	Mean Square	F	Sig.
SC 0-Between Groups	0.00	3	0.000	0.02	0.995
Within Groups	1.65	195	0.008		
Total	1.65	198			
SC 29-Between Groups	76.74	3	25.58	5.25	0.000
Within Groups	0.95	195	0.01		
Total	77.69	198			
SC 36-Between Groups	32.81	3	10.94	986.67	0.000
	2.16	195	0.01		
	34.97	198			

Within Groups Total					
PS 0-	**923.33**	**3**	**307.78**	**0.40**	**0.756**
Between Groups	**151648.89**	**195**	**777.69**		
Within Groups	**152572.21**	**198**			
Total					
PS 29-	**28100.54**	**3**	**9366.85**	**13.69**	**0.000**
Between Groups	**133436.06**	**195**	**684.29**		
Within Groups	**161536.59**	**198**			
Total					

Descriptive statistics of study and outcome variables measured in 52 and 48 subjects in experimental and control group respectively. The comparison of base line mean values of study variables (Table-1) and outcome variables (Table-2) among the two study groups, that is male shooters who had interventions: as music and control, shows a non statistically significant difference in the mean values of Age (F= 1.15; p= 0.33), BMI (F= 3.57; p=0.02), heart rate (HR) (F=0.10; p=0.96), respiratory rate (RR) (F=2.44;p=0.07), diastolic blood pressure (BPD) (F=0.42; p=0.74), and systolic blood pressure (BPS) (F=1.11; p=0.35) and SC(F=0.02; p=0.99), PS (F=0.40; p= 0.756).

In Experimental group, the mean values of Salivary Cortisol (SC) had statistically significantly decreased from the baseline value of 1.33 to 0.53 at 29th day and 0.91 at 36th day which is statistically significant (F=1.20;p<0.001). The post hoc pair wise comparison of these three values indicates highly statistically significant difference among the three values. From this it can be infer that the effect of music 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=-9.67, p<0.001).

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 these three values indicates highly statistically significant difference among the three values. From this it can be infer that the effect of no music 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).

Discussion

In the current study, used Salivary Cortisol (SC) as physiological markers and Performance Score (PS) as one subjective marker to assess the changes with music intervention group and also assessed changes in control group during the same duration. These parameters are very much reliable to provide true picture of changes and they are also very much susceptible for changes in pre competition anxiety or stress. This fact is supported by *(Filarie et al., 2007 and Hanesishi et al., 2004)* and also supported by research findings comparing the physiological and psychological markers of stress have been equivocal *(Filaire et al., 2001)*. Since the salivary cortisol assay has been proposed as the method of choice for assessing adrenocortical (endocrine) function and responses to competitive stress Thus in this study also included SC as a physiological marker.

Result have been proved, during intervention of music therapy, the cortisol level in saliva decreased in music group post-intervention 60% (.53) and follow-up 29% (.91). Whereas control group showed

an increase of 47% 1.95 and 26% 1.60 pre-competition and post competition respectively. Study also showed the pre and post competition performance score of experimental group has increased 3% (544) whereas control group showed a decrease of performance score 0.9% (518).

The result of the study indicated that there is an increase in post intervention and follow up values in experimental group was showing more effective whereas the control groups it was highly insignificant result. The reason for these changes might be supported by studies on competition stress have been observed *(Stephen D Mellalieu et. al., 2009)*, supported that, prior to competing, sport performers encounter more stressors pertinent to performance. The level of anxiety automatically narrows perception restricting the focus of attention *(Fredrickson & Branigan, 2005; Most et al., 2005; Curry et al., 2006; Ashcraft & Krause, 2007).* Thus result of this study indicated that there is an decrease in control group and increase in post intervention performance score in music therapy group; the reason for these changes might be due to decrease in pre competition stress.

supported by studies on cortisol have been observed, Cortisol is a hormonal response to acute stress and has been measured to be higher before competition than at resting conditions *(Salvador et al., 2003).* 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 *(Kirschbaum and Hellhammer, 1994).*

Music affects a reduction in sympathetic nervous control and therefore a reduction in heart and respiration rates, metabolism, oxygen consumption, muscle tension, *(Lee et al 2005).* Listening to classical music increases heart rate variability helps in stress reduction, whereas listening to noise or rock music decreases heart rate variability (reflecting greater stress) *(Chuang et al., 2010).* Also supported by reductions in autonomic activity and self-reported tension and improved performance of surgeons *(Allen and Blaskovich, 1994).* In the current study music therapy has also been given based on classical music that might have increased relaxation in groups which have under gone music interventions.

As repeated listening to music affects people's preference for it as well as their physiological responses to it *(Knight and Rickard, 2001),* Music appears to exert direct physiological effects through the autonomic nervous system *(Rakel et. al., 2003).* In our study we have given 20 minutes session for 4 weeks this could supports the more effect of music. In addition, lower anxiety is expected to promote psychological well being by decreasing plasma norepinephrine and cortisol (*Mockel et al., 1994)* and enhancing relaxation and calmness. Therefore, soothing music was expected to have a therapeutic effect on relaxation.

Result of the current study showed in experimental group have been shown some amount of follow up effects even after one week of intervention this is supported by studies such as, (*Caine, 1992)* found evidence that playing recorded music for infants in the neonatal intensive care unit increased weight gain and shortened lengths of stay. Moreover,

a follow-up study of the infants that participated in Caine's music listening study indicated that infants who participated in the music intervention were rated as calmer by their mothers at 6 months of age compared to infants without music intervention. The results concerning the affective component of symptom changes showed that the effect of music therapy was sustained. One week after the discontinuation of sessions *(Guetin et al., 2009).*

Conclusion

The neuroendocrine scientific studies of music is clearly still in its infancy, but the initial findings reviewed earlier promise both to reveal the mechanisms by which such training might exert its effects on relaxation that underlie complex regulatory mental functions. Results of this study indicated that relaxation therapies such as music therapy may decrease pre-competition stress and will enhance sports performance. It is concluded that in four weeks of music training has an effect on HPA-Axis by decreasing the level of salivary cortisol as a reliable physiological marker of pre-competition stress.

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.

To our knowledge, the salivary cortisol has been little evaluated in young athletes and, in such conditions of pre-competitive stress and post relaxation therapies. This work was made possible to find out the changes on the neuroendocrine (ANS and 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 *(Brunner et al., 2002),* depression *(Belmaker and Agam, 2008),* risk for cardiovascular disease *(Smith et al., 2005)* and cognitive decline *(Seeman et al., 1997).*

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