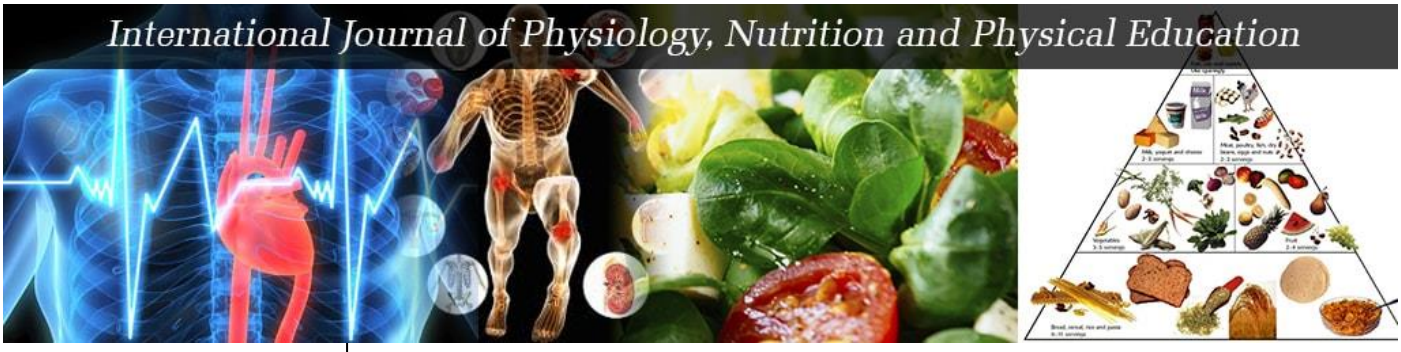

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Impact of novel pace bowling protocol on executive function

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Abstract
The aim of the study was to examine the effect of novel pace bowling protocol on executive function. Twenty male pace bowlers aged 19.55±1.61years, represented in CAB organized cricket league were assessed the executive function before and after four & eight over bowling spell by following the novel pace bowling protocol developed by Simon A. Feros (2017). The executive function was assessed by using computerized neurocognitive assessment (CNS Vital Signs VS4). The mean score of Pretest, Posttest1 and Posttest2 were 95.55±6.97, 100.2±6.6 and 107.7±8.54 respectively. Repeated measure ANOVA revealed that there were significant changes in executive function after both the bowling spell compare to pretest. From the result of the study, it can be concluded that novel pace bowling protocol has beneficial effect on executive function of cognition.

Keywords: Executive function, novel pace bowling protocol, pace bowling, bowling spell

Introduction
Pace bowling in cricket gets huge amount of interest to the researchers to provide scientific evidence to cure the art of pace bowling by interpreting all its technical influences. The bowling spell and its performance anticipatory aspects were the questions to guide the spell limitation of a pace bowler. The performance variables to measure for scientific research purpose is still in its infancy though no such standard test available to determine the performance related measures. Although Bowling Speed (BS), Bowling Accuracy (BA) and Consistency of Bowling Accuracy (CBA) were the measures till now are used to measure the performance of a pace bowler (Feros *et al*., 2017; Phillips *et al*., 2011) [5, 13]. Bowling speed is a great contributor of pace bowling (Wormgoor *et al*., 2010) [18] as it confined with speed of ball release to reach to the batsman very fast in nature. The fast bowling provide least time to the batsman to react and execute desirable cricket shot to the batsman. BA and CBA are the variables that defined with the measure of Radial Error and Bivariate Variable Error respectively (Feros *et al*., 2017) [5]. Radial error is the measure of impact close to target and Bivariate Variable Error denotes the consistency of minimal error of radial error in refence with two-dimensional coordinates of the target. The minimal the radial error and bivariate variable error, more the bowlers have accuracy and consistency. The approach to measure these variables come forth with Novel Pace bowling test with minimal four over and maximal eight over bowling spell. Bowling spell of six, eight even twelve over were well evidence to carried the technical properties without any kind of changes. Pace bowlers were evident to sustain the ball release speed along with maintaining technical properties of pace bowling (Callaghan *et al*., 2019) [3]. Even in case of ten over of bowling spell, a study well defined that young bowlers continue their bowling spell for Consistency in kinetic and kinematic pattern. The bowling spells were even subject of physiological analysis. A repeated six over spells for well-trained pace bowlers can moderately affect bowling performances but without any physiological changes (Duffield *et al*., 2009) [4]. Metabolic stress affected due to eight over of bowling spell (Thander & Seikh, 2020) [14]. For performance related factors such as bowling accuracy remain unchanged in a twelve over spell but the bowling spell decreased over time of young pace bowlers (Burnett *et al*., 1995) [1].

To continue the pace bowling spell a well maintain mental alertness and physical efficiencies. It is highly recommended that to improve performance and to perform in elite level, high amount of perceptual cognitive skill is required (Mann DT, 2017; Hopwood, Farrow, & Nielsen, 2011) [10, 7]. The pace bowling is an intermittent activity with moderate to high intensity is required. It has found that elite fast bowlers attempt 80-85% of maximum heart rate that sustain for short period of time (Johnstone *et al*., 2013) [8]. So, the workload for eight over of spell with sustaining the performance variable need strong attention and neurocognitive function. The scientific evidence proved that moderate to high intensity of exercise can influence neurocognitive aspects of brain. Executive function is one of the neurocognitive functions that denotes planning, problem solving, sequencing, selective and sustaining attention (Vestberg *et al*., 2017) [17]. The novel pace bowling protocol is still to examine its impact on neurocognitive function.

Aim of the study

The aim of the study was to examine the impact of novel pace bowling protocol on executive function to provide adequate evidence of its beneficial or harmful impact to the pace bowlers for its application in future research.

Methodology

Twenty (20) male pace bowlers aged 19.55±1.61years, represented Kolkata Division Cricket League through recognized clubs of Cricket Association of Bengal and played at least twenty matches were selected purposively for the study. The dependent variable, Executive function was measured by using computerized neurocognitive test (CNS Vital Signs VS4) in repeated measures; first in resting condition (Pre-test), second after completion of four over and third in completion of eight over in a laboratory set up. Novel Pace Bowling protocol was administered in two successive days with a gap of seven days even the same duration was maintained to obtain the data of executive function. The test was administered by the following guidelines of the target sheet, bowling sequences, bowling variability and live batsman. The phase was accomplished with collecting the data of executive function in a resting condition (Pre-test). The second phase was started with four over of bowling spell as prescribed by the protocol followed by the neurocognitive trail (Post-test-1). The third phase was started the eight over of bowling spell followed by the neurocognitive trail (Post-test-2). Repeated measure ANOVA was used to analyze the effect of the bowling spells on executive function.

Data Analysis

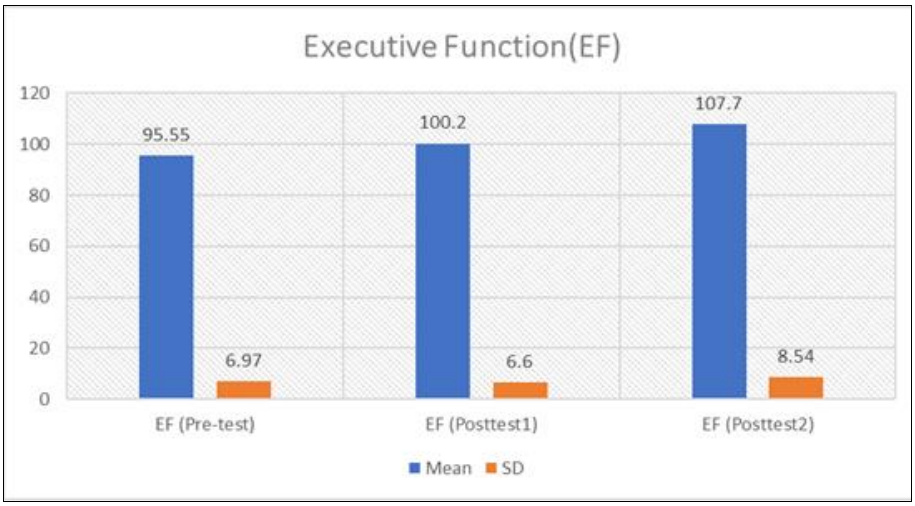

Fig 1: Mean and SD of Executive Function in Pre-test, Post-test-1 and Post-test-2

Table 1: Descriptive Statistics of Executive Function of Pre-test, Posttest1 and Posttest2

Time	Mean	SD	SEM	SK	KU	Max	Min
EF (Pre-test)	95.55	6.97	1.56	0.829	0.366	113	87
EF (Posttest1)	100.2	6.6	1.47	0.727	-0.308	115	92
EF (Posttest2)	107.7	8.54	1.91	0.57	-0.006	124	94

Table No.1 illustrated that the mean value of EF in pre-test was 95.55±6.97, whereas in posttest1 100.2±6.6 and in posttest2 107.7±8.54. The standard scores collected from test were increased overtime of repeated experimentation.

Table 2: Normality Test of the data of Executive Function of Pre-test, Posttest1 and Posttest2

Time	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
EF (Pre-test)	0.174	20	0.113	0.925	20	0.126
EF (Posttest1)	0.222	20	0.011	0.911	20	0.066
EF (Posttest2)	0.186	20	0.068	0.908	20	0.057

Table No.2 illustrated the Shapiro-Wilk test to determine the distribution of the data. The Shapiro-Wilk test did not showed evidence of non-normality of the data of Executive Function of Pre-test 9(W=0.925, p=0.126), Posttest1(W=0.911, p=0.066) and Posttest2 (W=0.908, p=0.057).

Table 3: Mauchly's Test of Sphericity

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Time (EF)	0.336	19.649	2	0.00*	0.601	0.619	0.5

Table No. shows the Mauchly's test of Sphericity for the assumption of relationship between the different pair of conditions. The test showed that the assumption of sphericity was violated $\chi^2(2) = 19.65$, $p<0.01$, so that the Epsilon of Greenhouse-Geisser will be used to adjust the degree of freedom as the epsilon was below 0.75

Table 4: Repeated Measure ANOVA

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity Assumed	1503.3	2	751.65	49.13	0.00*	0.721
	Greenhouse-Geisser	1503.3	1.202	1250.987			
	Huynh-Feldt	1503.3	1.238	1214.323			
	Lower-bound	1503.3	1	1503.3			
Error (Time)	Sphericity Assumed	581.367	38	15.299			
	Greenhouse-Geisser	581.367	22.832	25.463			
	Huynh-Feldt	581.367	23.521	24.716			
	Lower-bound	581.367	19	30.598			

Table No. 4 shows the repeated measure ANOVA to find out the effect two different bowling spells on Executive Function (EF) of Neurocognitive Function with Greenhouse-Geisser correction of adjusting the degree of freedom. The result showed significant effect of bowling spells on Executive Function, F (1.20, 22.83) = 49.13, $p<0.05$ $\eta p^2=0.72$

Table 5: Pairwise Comparison (Post-hoc Test)

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Diffference[b]	
					Lower Bound	Upper Bound
Pre-test	Posttest1	-4.650*	0.751	0.00*	-6.623	-2.677
	Posttest2	-12.150*	1.642	0.00*	-16.46	-7.84
Posttest1	Pre-test	4.650*	0.751	0.00*	2.677	6.623
	Posttest2	-7.500*	1.153	0.00*	-10.526	-4.474
Posttest2	Pre-test	12.150*	1.642	0.00*	7.84	16.46
	posttest1	7.500*	1.153	0.00*	4.474	10.526

Table No.5 shows the pairwise comparison of means of conditions to estimate the effect difference between pre-test and post-test1, post-test1 and post-test2 and pre-test and post-test2. The Mean difference showed significant differences between pre-test and posttest1 (Mean difference= -4.65, $p<0.05$); pre-test and post-test2 (Mean difference= -12.15, $p<0.05$); post-test1 and post-test2 (Mean difference= -7.50, $p<0.05$).

Discussion on Findings

The result of study provided positive influences to the neurocognitive function called executive function. Though the analysis having a tendency of Type-I error, but the post hoc test revealed that the mean scores of executive functions increased over time of bowling spell. The probable reason may be the workload of the test. The workload may be sustained with moderate intensity overall to the subject. The physiological consequences of the workload is to supply of sufficient oxygen to the brain physical arousal (Tian *et al*., 2021) [15]. Exercise intensities especially moderate intensity is highly corelated with brain activation and executive function of the brain (Mehren *et al*., 2019) [11]. The whole activity sustained for more than twenty-four minutes (four over spell) and forty-eight minutes (eight over spell), it was aerobic in nature. It had found that physiological arousal perceptual processing can be promoted by acute aerobic exercises (Zhou & Qin, 2019) [19]. The mechanism behind improved executive function after moderate intensity exercises may be increased arousal level and evoked task related cortical activation on the left dorso-frontal cortex and left frontopolar area (Byun *et al*., 2016) [2]. The increased effect of executive function may sustain for thirty minutes after completion of exercise (Peiffer *et al*., 2015) [12].

The attentional properties of the test may have an influential role to improve EF. The test exhibits variability in bowling speed, target and situational aspects that allowed the subject to perform each ball with careful attention. The repeated targ*et al*so allowed the bowler to correct the errors with adaptation and adjustment in the thought process as well as execution. The subcomponents of Executive function are working memory and cognitive flexibility are well improved by sports activities program consists with cognitive stimuli (Gentile *et al*., 2020) [6]. The demand of cognitive approaches through the dynamic aspects of the event is effective to develop executive function (Koch & Krenn, 2021) [9]. The sports with challenging and continuously changing tasks the higher level of performers possessed distinguished ability in executive function (Verburgh *et al*., 2014) [16].

Conclusion

On the basis of the result, it can be concluded that novel pace bowling protocol have positive influential effect on executive function.

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