

CHAPTER 6

6.0 Results

All statistical analyses were performed using the computing environment R (version 3.4.0). Descriptive statistics were expressed as a mean \pm standard deviation for continuous variables. Categorical variables are presented as frequencies (Percentage). The normality of quantitative variables was determined using the Shapiro-Wilk test and visual inspection of the normal Q&Q plot. Univariate statistics on the differences between baseline variables are calculated by the χ^2 test, the Mann–Whitney test or Student's t-test. For all analysis, statistically, significance was considered at $p < 0.05$. A paired sample t-test was used to determine whether there was a statistically significant mean difference between pre and post intervention. Further, effect size, Cohen's d , was calculated for a paired-samples t-test by dividing the mean difference by the standard deviation of the difference (Cohen, 1988).

6.1 Baseline description

For this study 110 substance abuser was recruited, 14 participants were excluded because of various reasons. Data was randomized for 96 substance abusers. In the yoga group, 4 subjects dropped out and in the physical group, 5 participants were dropped. The reason for dropout is enlisted in the trail profile, so 44 in the yoga group and 43 in the physical group were analyzed. The age of all participants in the yoga group was 25.18 ± 6.43 [18-40] and in the physical group was 25.02 ± 5.02 [18-37]. Table 15 summarizes sociodemographic, and outcome measures at baseline and no significant differences were observed at baseline in age, education, marital status, years of substance use, type of drug addiction and outcome parameters between the two groups. Final

available data for analysis were 87 substance abusers, yoga (n=44) and physical exercise (n=43). No significant differences were observed at baseline in socio-demographic profile and substance abuse related outcomes between the two groups.

6.1.1 Baseline characteristics of the yoga and exercise groups

[Table 15]

		Yoga (44)	Physical (43)		
Variable		Mean±SD	Mean±SD		<i>p</i> value
Age		25.18±6.43[18-40]	25.02±5.02[18-37]	U = 904.5, z = -0.35	p=0.724
		Frequency (%)	Frequency (%)		
Education	≤Intermediate Level	29(65.91)	27(62.79)	$\chi^2(1) = 0.09$	p=0.761
	Bachelor and above	15(34.09)	16(37.21)		
Marital	Married	11(25)	12(27.91)	$\chi^2(1) = 0.09$	p = 0.759
	Unmarried	33(75)	31(72.09)		
Alcohol	No	8(18.18)	9(20.93)	$\chi^2(1) = 0.1$	p = 0.747
	Yes	36(81.82)	34(79.07)		
Cannabis	No	8(18.18)	6(13.95)	$\chi^2(1) = 0.29$	p = 0.592
	Yes	36(81.82)	37(86.05)		
Opiates	No	13(29.55)	13(30.23)	$\chi^2(1) = 0$	p = 0.944
	Yes	31(70.45)	30(69.77)		
Tranquillizers	No	22(50)	22(51.16)	$\chi^2(1) = 0.01$	p = 0.914
	Yes	22(50)	21(48.84)		
Stimulants	No	17(38.64)	19(44.19)	$\chi^2(1) = 0.28$	p = 0.599
	Yes	27(61.36)	24(55.81)		
Inhalants	No	23(52.27)	22(51.16)	$\chi^2(1) = 0.01$	p = 0.918
	Yes	21(47.73)	21(48.84)		

	Mean±SD	Mean±SD		
Years of Substance Use	7.63±6.03	6.72±4.95	U = 884, z =-0.53	p =0.597
Digit Forward	10.2±2.6	10.62±2.51	U = 849.5, z =-0.83	p =0.407
Digit Backward	6.97±1.48	7.41±1.29	U = 758, z =-1.64	p =0.1
Age at Substance Use	17.5±2.56	17.95±3.22	t(85) =-0.73	p =0.47
Cancellation Net Score	32.4±10.34	30.88±11.12	t(85) =0.66	p =0.51
Stroop Word Score	104.75±16.76	102.48±16.84	t(85) =0.63	p =0.532
Stroop Color Score	63.27±12.09	64.55±14.6	t(85) =-0.45	p =0.656
Stroop Word – Color Score	38.5±7.48	39.39±10.32	t(85) =-0.46	p =0.644

6.2 Cognitive function

6.2.1 Pre-post comparison of cognitive profiles in yoga and physical exercise groups

[Table 16]

Measures	Yoga (n=44)					Exercise (n=43)				
	Pre	Post	95% CI	<i>t</i>	<i>P</i>	Pre	Post	95% CI	<i>t</i>	<i>p</i>
Digit Forward	10.2 (2.6)	12.22 (2.36)	(-2.77 to - 1.26)	-5.405	0.0005	10.62 (2.51)	11.97 (2.7)	(-1.91 to -0.78)	-4.814	0.0005
Digit Backward	6.97 (1.48)	8.56 (1.94)	(-2.14 to - 1.04)	-5.835	0.0005	7.41 (1.29)	8.32 (1.7)	(-1.38 to -0.42)	-3.823	0.0005
Cancellation Net Score	32.4 (10.34)	42.59 (13.17)	(-12.54 to -7.82)	-8.695	0.0005	30.88 (11.12)	42.04 (13.52)	(-13.61 to -8.71)	-9.191	0.0005
Stroop Word Score	104.75 (16.76)	113.09 (15.85)	(-11.75 to -4.92)	-4.925	0.0005	102.48 (16.84)	111.16 (18.65)	(-12.98 to -4.36)	-4.058	0.0005
Stroop Color Score	63.27 (12.09)	72.75 (11.25)	(-12.02 to -6.93)	-7.515	0.0005	64.55 (14.6)	71.32 (10.91)	(-10.16 to -3.36)	-4.016	0.0005
Stroop Word – Color Score	38.5 (7.48)	45.75 (7.25)	(-9.25 to - 5.24)	-7.292	0.0005	39.39 (10.32)	43.2 (8.55)	(-6.63 to -0.98)	-2.725	0.009

Table 16 includes within-group comparisons of yoga and exercise groups on outcomes following three months. No outliers were detected as assessed by inspection of a box plot for a value greater than 1.5 box length. The assumption of normality was not violated on different scores, as assessed by Shapiro-Wilk tests and visual inspection of the normal Q&Q plot. A significant enhancement in digit forward was observed in both the yoga ($p < 0.0005$, $d= 0.81$) and the exercise group ($p < 0.0005$, $d= 0.73$). Post yoga intervention shows differences on digit backward, namely statistically significant increased mean in yoga ($p < 0.0005$, $d=0.88$) and exercise ($p < 0.0005$, $d=0.58$). The magnitude of change was higher in the yoga group. Further, on the cancellation task, a significant increase was noted in yoga ($p < 0.0005$, $d=1.31$) and exercise group ($p < 0.0005$, $d=1.4$). The results from the Stroop word and color tests were significantly greater post compared with their respective pre-scores following yoga ($p < 0.005$, $d=0.74$; $p < 0.005$, $d=1.13$) and exercise ($p < 0.0005$, $d=0.62$. $p < 0.0005$, $d=0.61$). The degree of variation was higher in the yoga group. Furthermore, Stroop color-word test shown significant enhancement after yoga ($p < 0.0005$, $d=1.10$) and exercise ($p < 0.0005$, $d=0.42$), with differences high in yoga group following three months.

6.2.2 Mean group comparisons of cognitive function scores between pretest and post-test
[Table 17]

	Yoga (n=44)	Exercise (n=43)		
Variable	Mean±SD	Mean±SD	t value	p value
Digit Forward	-2.02±2.48	-1.34±1.83	t(85) =-1.44	p =0.154
Digit Backward	-1.59±1.8	-0.9±1.55	t(85) =-1.89	p =0.062
Cancellation Net Score	-10.18±7.76	-11.16±7.96	t(85) =0.58	p =0.562
Stroop Word Score	-8.34±11.23	-8.67±14.01	t(85) =0.12	p =0.903
Stroop Color Score	-9.47±8.36	-6.76±11.04	t(85) =-1.29	p =0.2
Stroop Word – Color Score	-7.25±6.59	-3.81±9.17	t(85) =-2.01	p =0.048

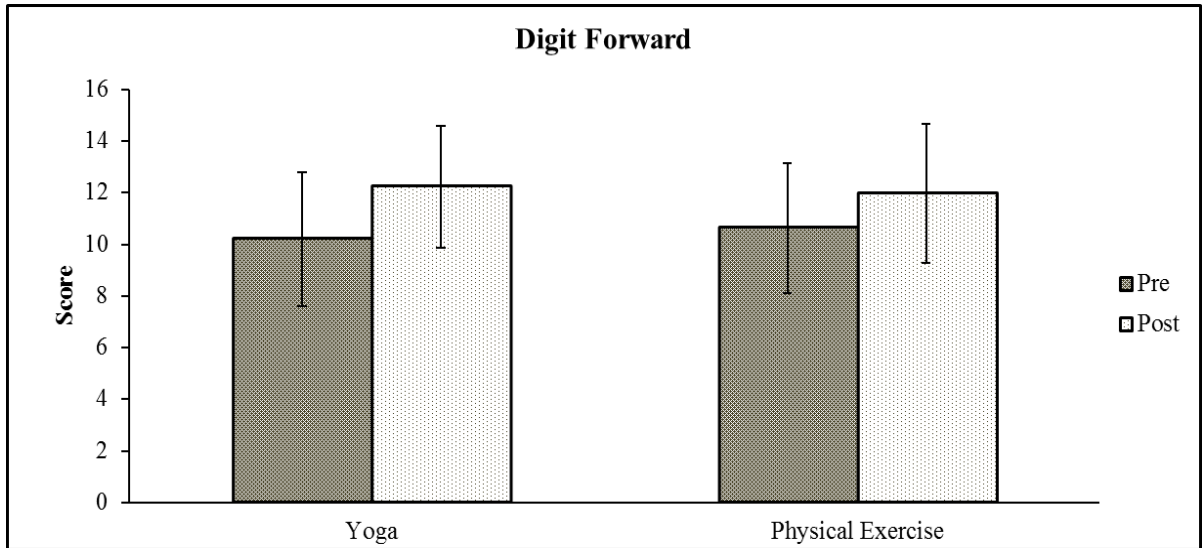
*Mean scores were computed as differences between post-test and pre-test

Differences between the yoga and physical exercise groups were analyzed using independent samples t-test are summarized. The homogeneity of variance is not violated as assessed by Levene's test for equality variances. However, when the changes in the parameters assessed were compared, there were no significant differences between the yoga and exercise group in five of the assessed parameters, but there is significant change in stroop word color score.

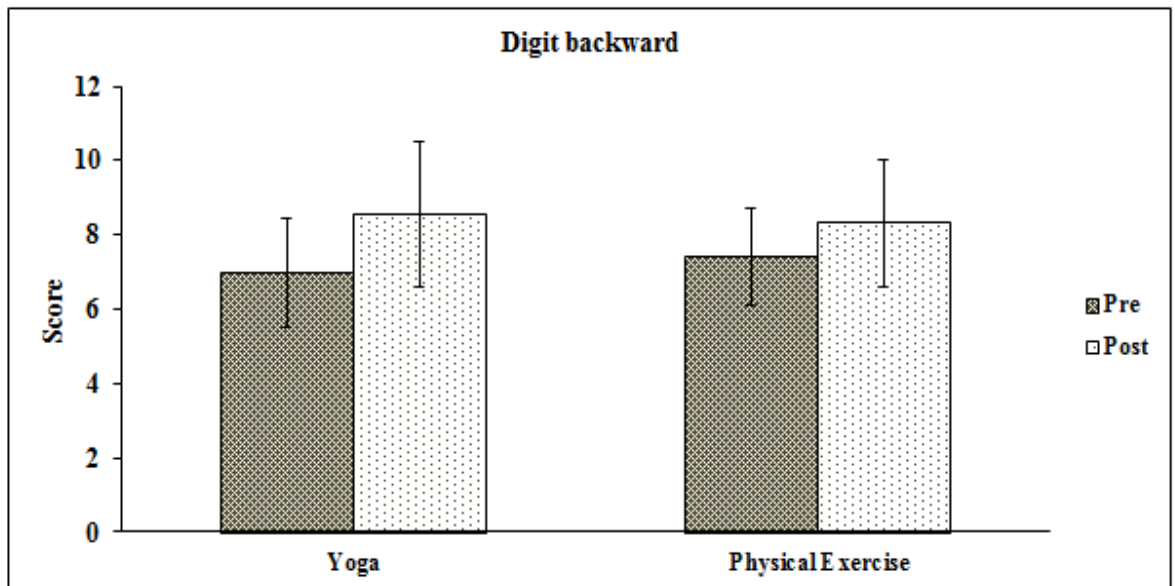
6.2.3 Graphs

Comparison of Digit Forward test scores between the Yoga & Physical groups

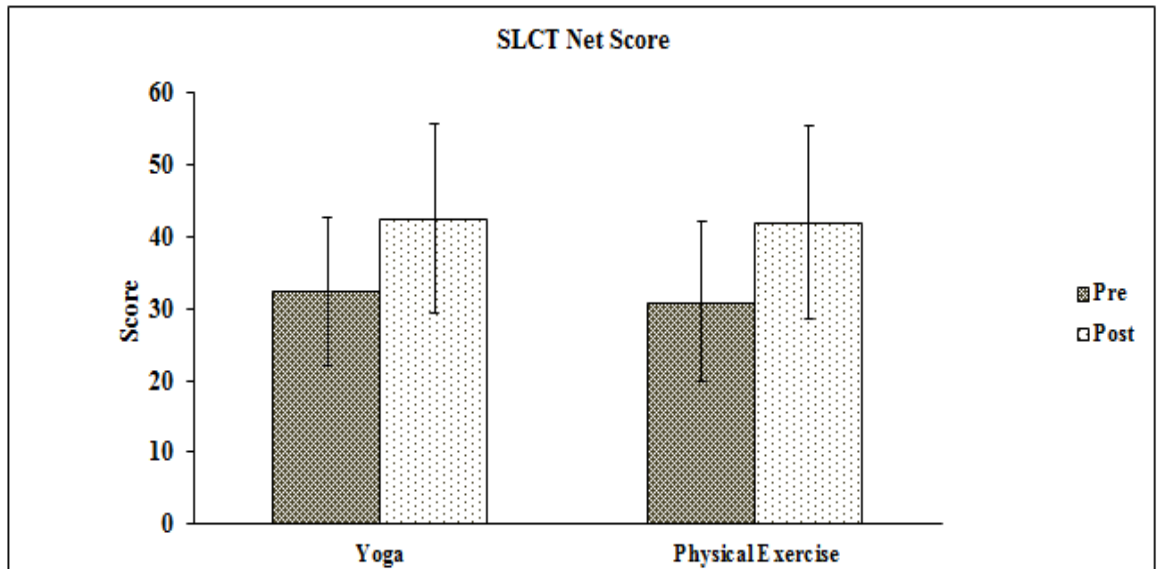
(Mean \pm SD) [PIC 2]



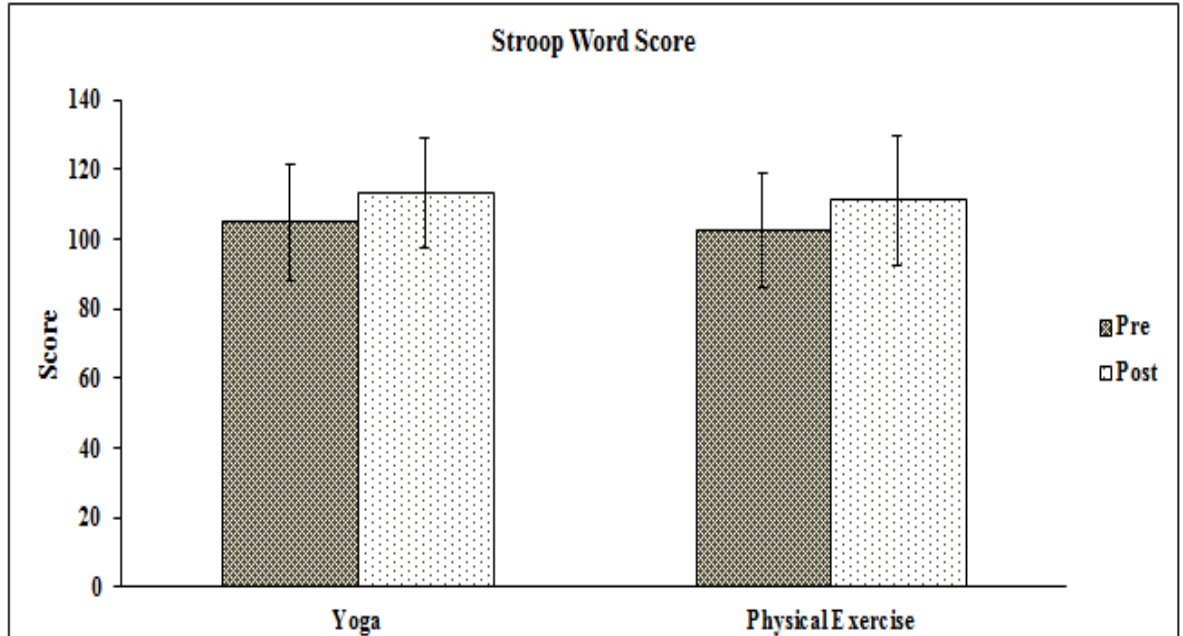
Comparison of Backward tests scores between the Yoga & Physical groups (Mean \pm SD) [PIC 3]



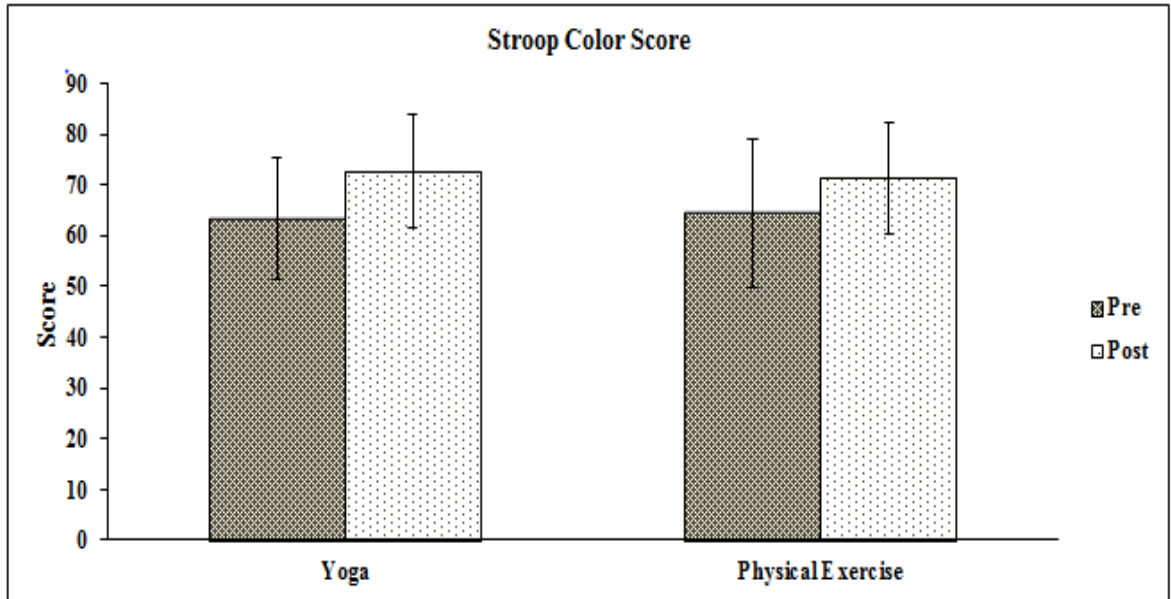
Comparison of Digit SLCT scores between the Yoga & Physical groups (Mean \pm SD) [PIC 4]



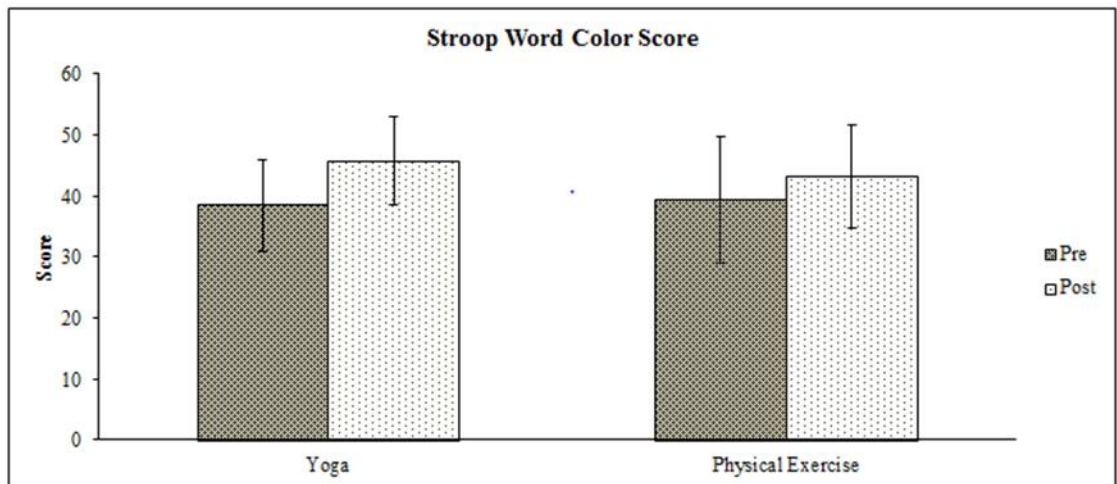
Comparison of Stroop Word Score between the Yoga & Physical groups (Mean \pm SD) [PIC 5]



Comparison of Stroop Color Score between the Yoga & Physical groups (Mean \pm SD) [PIC 6]



Comparison of Stroop Word Color Score between the Yoga & Physical groups (Mean \pm SD) [PIC 7]



6.3 Results of motor functions

6.3.1 Comparison of motor function in yoga and physical exercise groups

[Table 18]

Measures	Yoga (n=32)						Exercise (n=31)					
	Pre	Post	95% CI	<i>t</i>	<i>p</i>	<i>d</i>	Pre	Post	95% CI	<i>t</i>	<i>p</i>	<i>d</i>
Tapping 10s	37.00 (7.81)	40.16 (7.44)	(-5.29 to - 1.01)	-3.05	0.005	-0.53	38.45 (7.72)	40.81 (6.35)	(-4.41 to -.30)	-2.34	0.026	-0.42
Tapping 20s	35.28 (8.02)	37.59 (7.33)	(-4.47 to - .16)	-2.19	0.036	-0.35	35.71 (7.73)	38.39 (6.004)	(-5.11 to -.24)	-2.24	0.032	-0.40
Tapping 30s	26.59 (8.45)	29.19 (7.17)	(-5.49 to .30)	-1.82	0.078	-0.32	28.03 (8.65)	29.06 (6.39)	(-3.96 to1.90)	-.72	0.478	-0.13
Tweezer Dexterity	471.91 (81.79)	412.62(76.92)	(37.85 to 80.77)	5.64	0.000	0.99	458.32(90.68)	393.65(88.99)	(35.87 to 93.48)	4.58	0.000	0.82
Mirror Time	83.25(37.46)	67.50(35.19)	(1.24 to 30.25)	2.21	0.034	0.39	71.32(30.17)	58.19(28.64)	(4.05 to 22.21)	2.95	0.006	0.53

A significant enhancement in tapping speeds between 0-10 seconds (TS1) were observed in both the yoga ($p < 0.05$, $d = -0.53$) and the exercise group ($p < 0.026$, $d = -0.42$). Post intervention shows differences in 10-20 seconds (TS2), statistically significantly increased mean in yoga ($p < 0.036$, $d = -0.35$) and exercise ($p < 0.032$, $d = -0.40$). Furthermore, on the 20-30 seconds (TS3), improvement were noted in yoga ($p < 0.078$, $d = -0.32$) and exercise group ($p < 0.478$, $d = -0.13$), but not statistically significant. The results from the tweezer dexterity were significantly better, post compared with their respective pre-scores following yoga ($p < 0.001$, $d = 0.99$) and exercise ($p < 0.001$, $d = 0.82$). Furthermore, a significant reduction was seen in Mirror time after yoga ($p < 0.034$, $d = 0.39$) and exercise ($p < 0.006$, $d = 0.53$), with differences high in exercise group following 3 months.

6.3.2 Comparison of Mirror error in yoga and physical exercise groups [Table 19]

	Motor function Yoga				Motor function Exercise			
Measures	Pre	Post	<i>p</i>	<i>Z</i>	Pre	Post	<i>p</i>	<i>z</i>
Mirror error	19.5	17	.046	-1.991	21	18	.112	-1.590

Wilcoxon signed-rank test shown a statistically significant median decrease in mirror error score when subjects imbibed the yoga compared to the pre (19.50), $z = -1.991$, $p = .046$. While following physical exercise, median reduced in mirror error score to (18) compared to the pre (21), $z = -1.590$, $p = .112$, but not statistically significant.

6.3.3 Mean group comparisons of Motor function scores between pretest and post-test

Table [20]

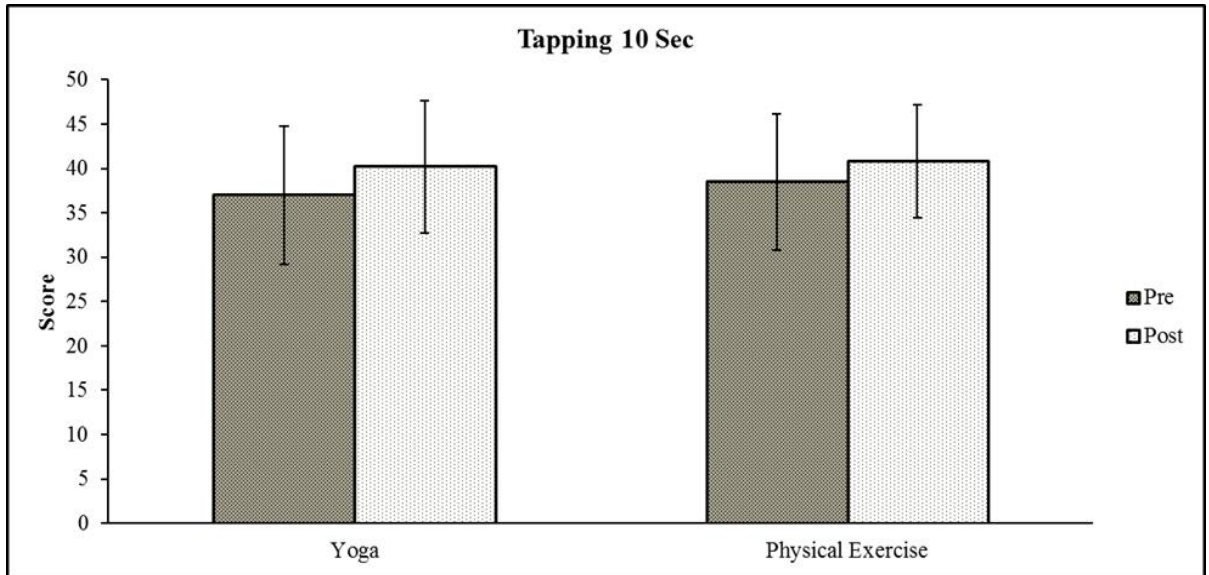
	Yoga	Physical		
Variables	Mean±SD	Mean±SD	<i>t</i> value	<i>p</i> value
Tapping10s	3.15±5.94	2.35±5.60	<i>t</i> (61)=-.551	.584
Tapping20s	2.31±5.98	2.68±6.64	<i>t</i> (61)=.229	.819
Tapping30s	2.59±8.03	1.03±7.99	<i>t</i> (61)=-.773	.443
Tweezer Dexterity	-59.31±59.52	-64.67±78.52	<i>t</i> (61)=-.310	.760
Mirror Time	-15.75±40.24	-13.13±24.74	<i>t</i> (61)=.310	.765
Mirror Error	-10.34±27.66	-10.54±28.63	<i>t</i> (61)=-.029	.977

Differences between the yoga and physical exercise groups, summarized in Table.20 However, when the between-group changes in the parameters were compared, there were no significant differences between the yoga and exercise group in any of the evaluated motor functions.

6.3.4 Graphs

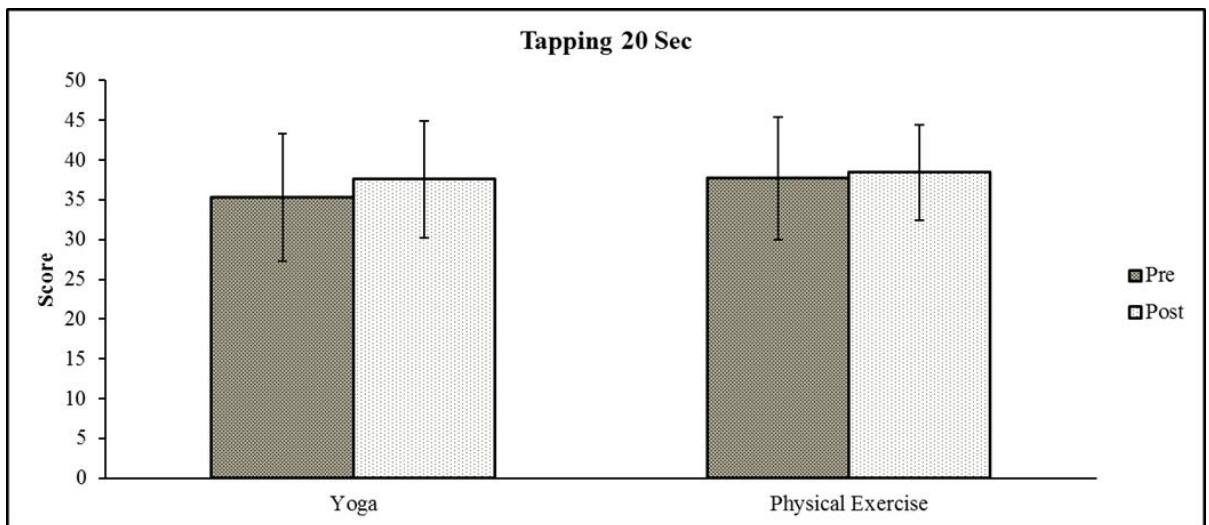
Comparison of Tapping 10 Sec between the Yoga & Physical groups (Mean \pm SD)

[PIC 8]



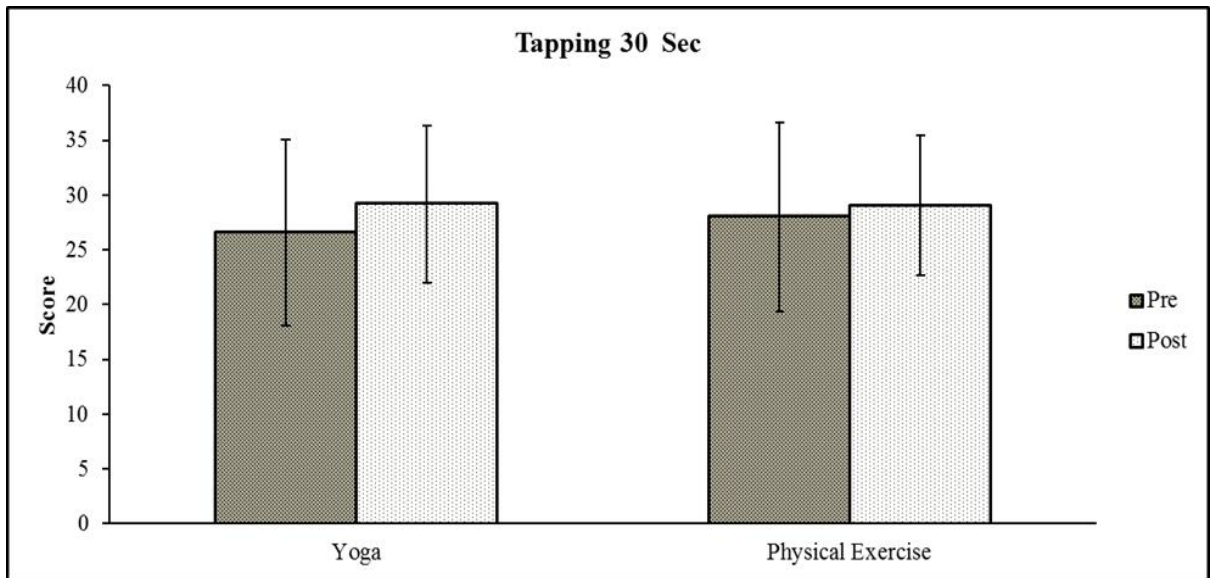
Comparison of Tapping 20 Sec between the Yoga & Physical groups (Mean \pm SD)

[PIC9]

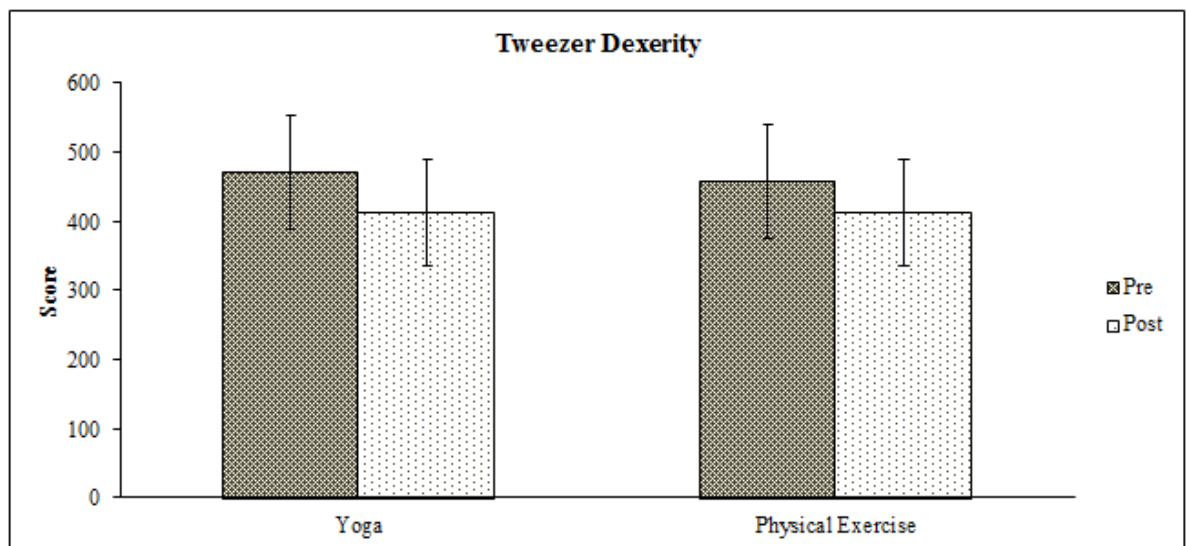


Comparison of Tapping 30 Sec between the Yoga & Physical groups (Mean \pm SD)

[PIC 10]

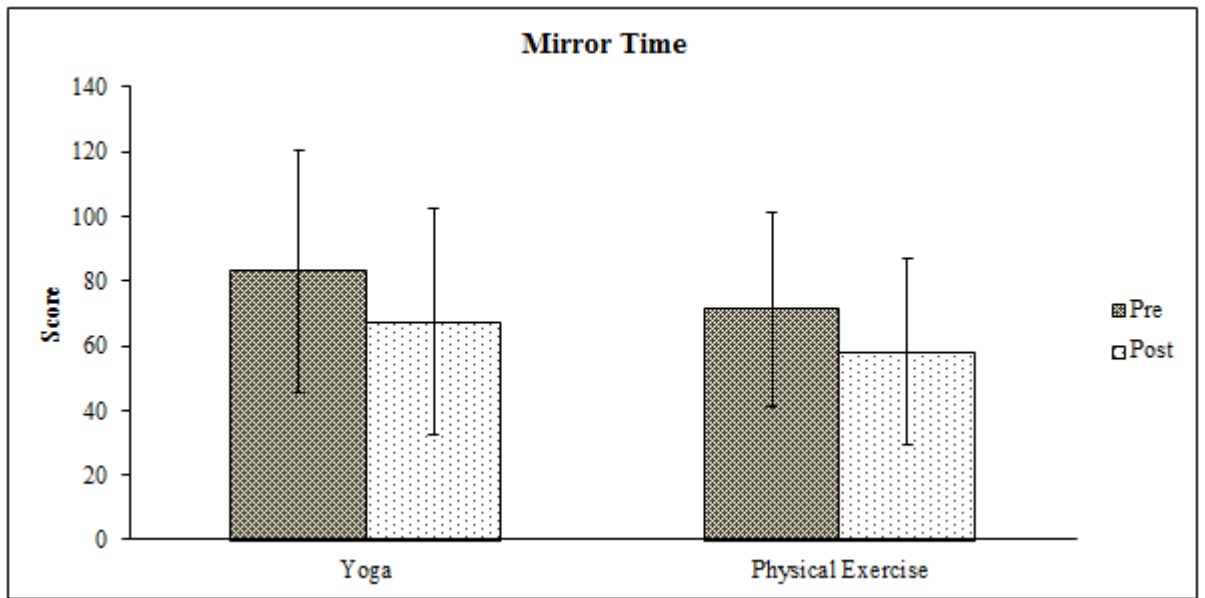


Comparison of Tweezer Dexterity between the Yoga & Physical groups (Mean \pm SD) [PIC 11]



Comparison of Mirror Time between the Yoga & Physical groups (Mean \pm SD)

[PIC 12]



6.4 Psychological well beings

Includes within-group comparisons of yoga and exercise groups on outcomes following 12 weeks. A significant enhancement in self-control was observed in both the yoga ($p < 0.033$, $d=0.33$) and the exercise group ($p < 0.038$, $d=0.32$). Post yoga intervention showed statistically significant differences in mindfulness in yoga ($p < 0.017$, $d=0.37$), whereas in the exercise group, did not find significant differences in mindfulness ($p < 0.169$, $d=0.21$). The magnitude of change was higher in the yoga group. The results from the depression and anxiety were significantly less post compared with their respective pre-scores following yoga ($p < 0.044$, $d=0.31$; $p < 0.025$, $d=0.35$) and exercise ($p < 0.032$, $d=0.34$. $p < 0.039$, $d=0.32$.). The degree of variation was higher in the yoga group. Furthermore, significant enhancement was seen in sleep disturbance after yoga ($p < 0.001$, $d=0.52$) and exercise ($p < 0.001$, $d=0.78$). Further, on the somnolence, a significant reduction was noted in yoga ($p < 0.020$, $d=0.36$), meanwhile exercise group did not change significantly ($p < 0.138$, $d=0.23$). There were no significant differences observed in yoga and exercise group on snoring and sleep awaking parameters. The results from the sleep adequacy and quality of sleep were significantly higher compared to post with their respective baseline following yoga ($p < 0.016$, $d=-0.37$; $p < 0.010$, $d=-0.41$) and exercise ($p < 0.032$, $d=-0.34$. $p < 0.020$, $d=-0.37$).

6.4.1 Pre-post comparison of psychological profiles in yoga & physical exercise groups
[Table 21]

Measures	Yoga (n=44)						Exercise (n=43)					
	Pre	Post	95% CI	<i>t</i>	<i>p</i>	<i>d</i>	Pre	Post	95% CI	<i>t</i>	<i>p</i>	<i>d</i>
Brief self-control	38.64(7.44)	41.14(6.29)	-4.79 to -.21	-2.19	.033	-0.33	38.21(6.62)	40.58 (4.87)	-4.61 to -.14	-2.14	0.38	-0.33
Freiburg	36.05(7.29)	38.70(4.69)	-4.81 to -.51	-2.49	.017	-0.37	35.51(5.97)	36.93(5.14)	-3.46 to .625	-1.40	.169	-0.21
HADS anxiety	11.02(4.41)	9.30(3.85)	.223 to 3.23	2.32	.025	0.35	11.14(3.01)	10.16(2.46)	.050 to 1.90	2.13	.039	0.32
HADS depression	8.45(3.67)	7.02(3.72)	.039 to 2.82	2.07	.044	0.31	8.60(3.29)	7.23(2.87)	.125 to 2.60	2.22	.032	0.34
SSMOS sleep disturbance	219.77(101.21)	150.68(79.80)	28.58 to 109.6	3.44	.001	0.52	239.42(78.88)	146.98(97.98)	55.99 to 128.89	5.12	.001	0.78
SSMOS somnolence	136.82(78.59)	105.0(72.56)	5.32 to 58.32	2.42	.020	0.36	135.35(60.45)	117.67(64.76)	-5.91 to 41.26	1.51	.138	0.23
SSMOS snoring	30.91(35.16)	27.27(30.53)	-7.19 to 14.47	.68	.502	0.10	33.49(34.00)	23.72(29.03)	-4.34 to 23.88	1.39	.170	0.21
SSMOS sleep awaking	47.27(33.99)	40.00(31.69)	-3.78 to 18.33	1.33	.192	0.19	43.72(32.15)	39.07(32.06)	-7.42 to 16.73	.777	.441	0.12
SSMOS sleep adequacy	85.00(53.89)	112.53(54.06)	-49.99 to -5.46	-2.51	.016	-0.37	81.86(51.23)	109.30(48.7)	-52.39 to -2.49	-2.22	.032	-.34
SSMOS quality of sleep	5.86(1.79)	6.64(1.04)	-1.35 to -.198	-2.71	.010	-0.41	5.93(1.82)	6.65(1.13)	-1.32 to -.119	-2.42	.020	-.37

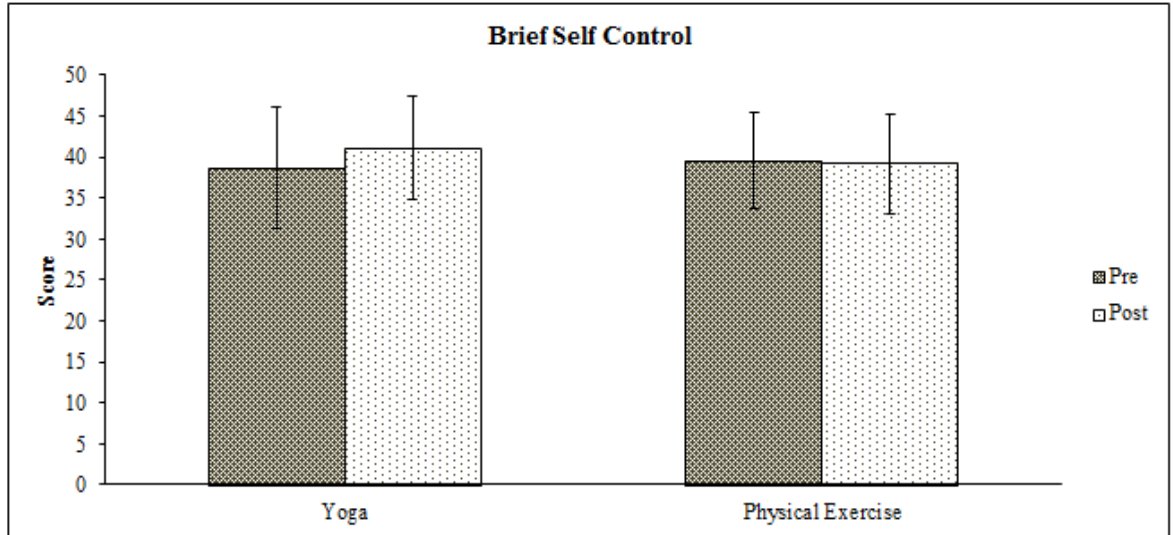
6.4.2 Mean group comparisons of Psychological variables score between pretest and post-test
[Table 22]

	Yoga (n=44)	Exercise (n=43)		
Variable	Mean±SD	Mean±SD	t value	p value
Brief self-control	-2.50±7.54	-2.37±7.25	t(85) =-.081	p =.936
Freiburg mindfulness	.57±7.55	1.77±6.59	t(85) =-.843	p =.402
HADS anxiety	1.73±4.95	.98±3.01	t(85) =.852	p =.396
HADS depression	1.43±4.58	1.37±4.05	t(85) =.064	p =.949
SSMOS sleep disturbance	69.09±133.24	92.44±118.43	t(85) =-.863	p =.390
SSMOS somnolence	31.82±87.16	17.67±76.62	t(85) =.803	p =.424
SSMOS snoring	3.64±35.64	9.77±45.85	t(85) =-.697	p =.488
SSMOS sleep awaking	7.27±36.37	4.65±39.24	t(85) =.323	p =.747
SSMOS sleep adequacy	-27.73±73.23	-27.44±81.07	t(85) =-.017	p =.986
SSMOS quality of sleep	-.77±1.89	-.72±1.96	t(85) =-.126	p =.900

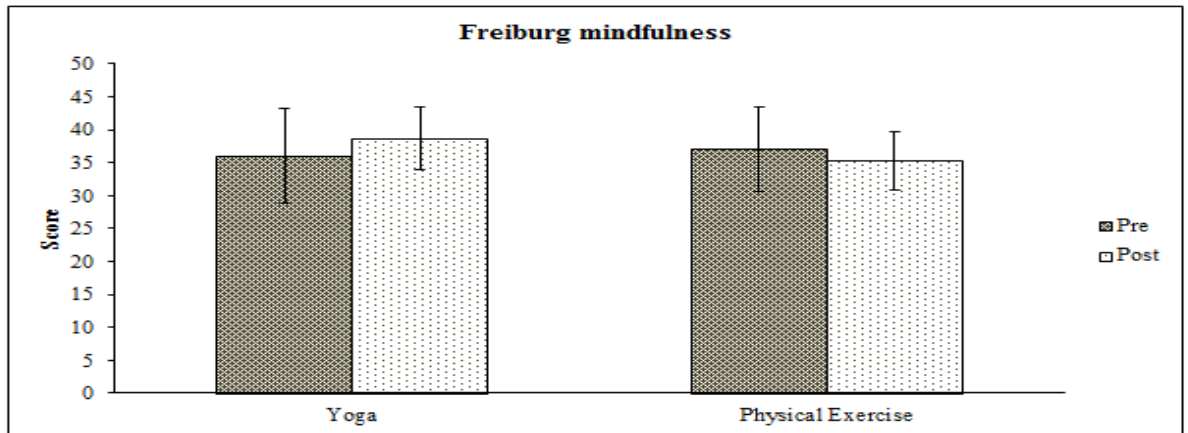
Mean difference scores were computed between post-test and pre-test intervention for between-group comparisons. However, when the changes in the parameters assessed were compared, there were no significant differences between the yoga and exercise group in any of the assessed parameters.

6.4.3 Graphs

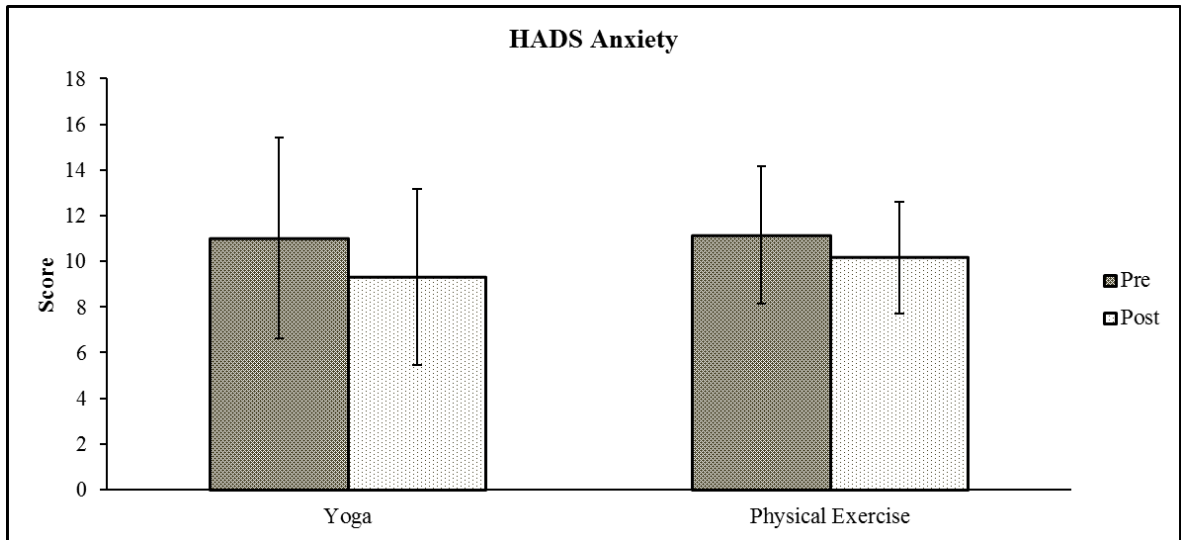
Comparison of Brief Self Control between the Yoga & Physical groups (Mean \pm SD) [PIC 13]



Comparison of Freiburg Mindfulness between the Yoga & Physical groups (Mean \pm SD) [PIC 14]

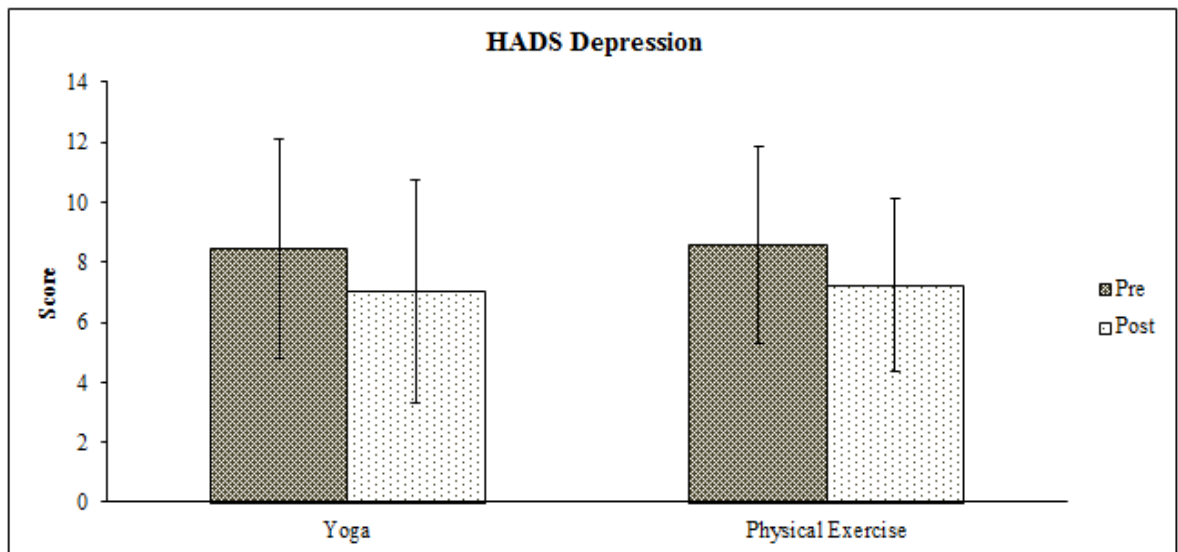


Comparison of HADS Anxiety between the Yoga & Physical groups (Mean \pm SD)



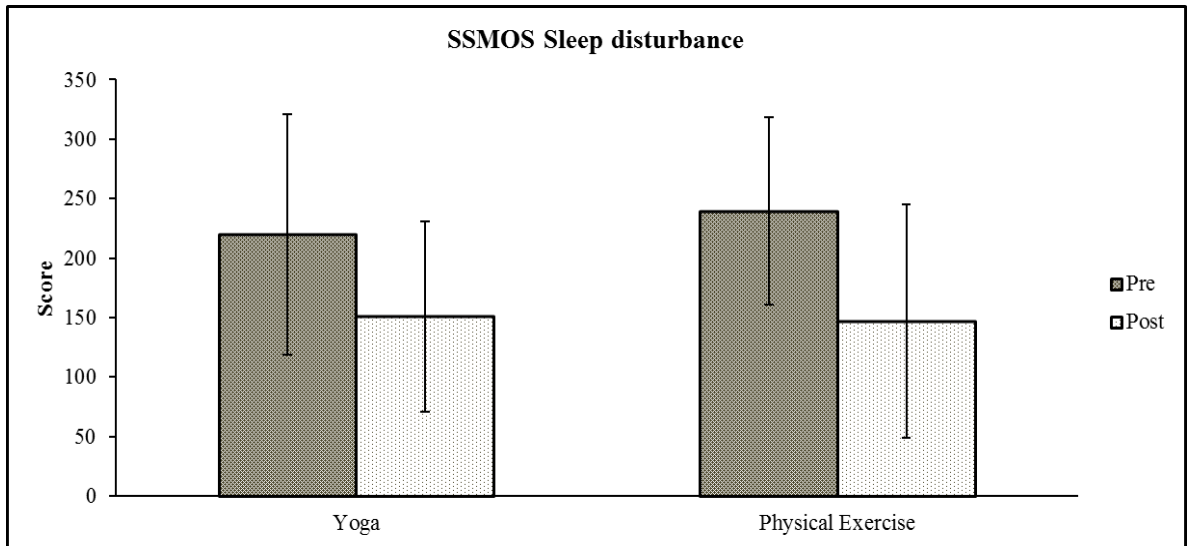
[PIC 15]

Comparison of HADS Depression between the Yoga & Physical groups (Mean \pm SD) [PIC 16]

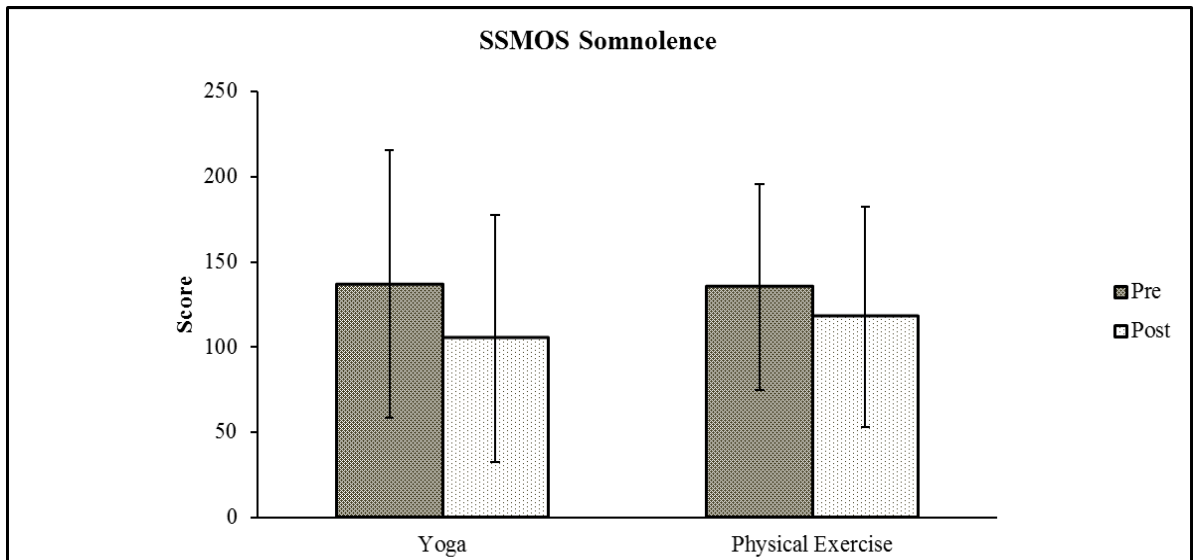


Comparison of SSMOS Sleep disturbance between the Yoga & Physical groups

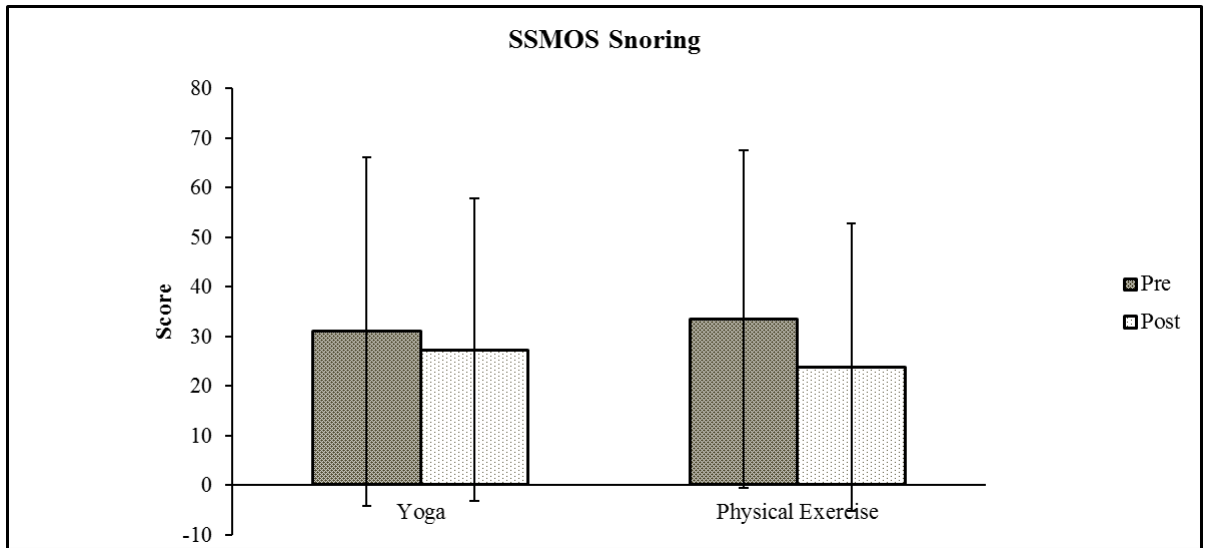
Mean \pm SD) [PIC 17]



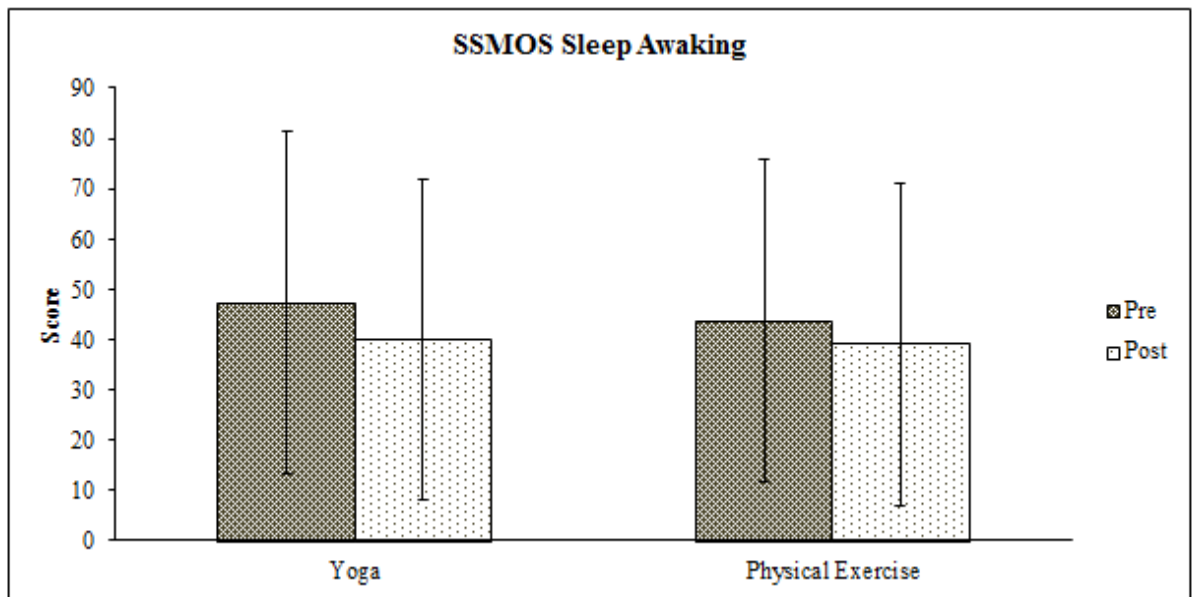
Comparison of SSMOS Somnolence between the Yoga & Physical groups (Mean \pm SD) [PIC 18]



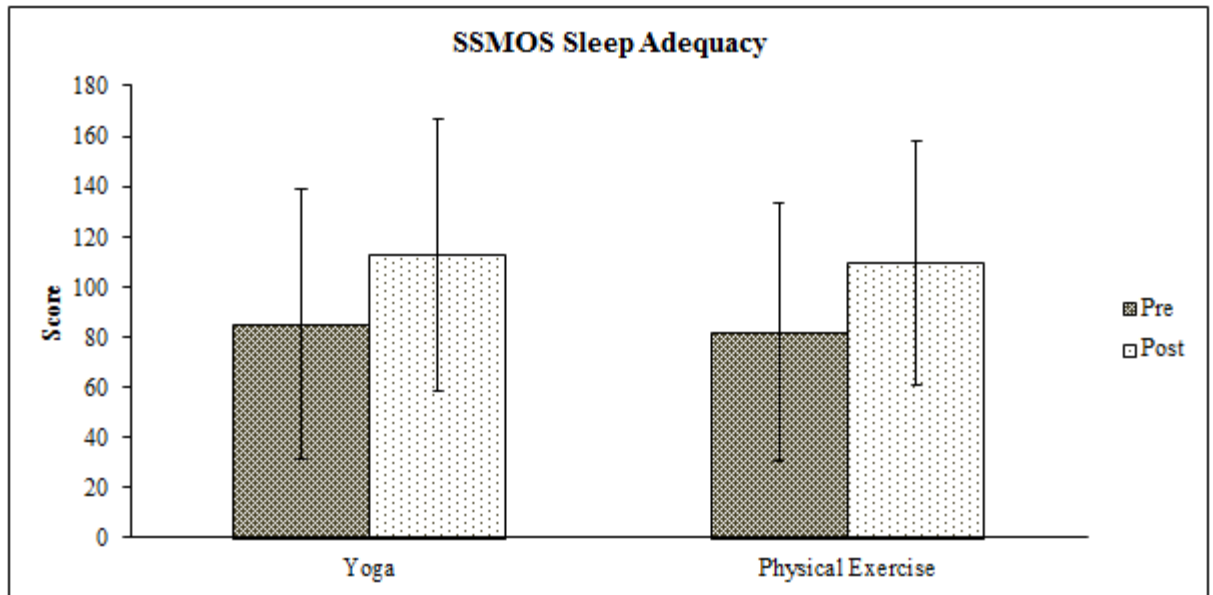
Comparison of SSMOS Snoring, between the Yoga & Physical groups (Mean \pm SD) [PIC 19]



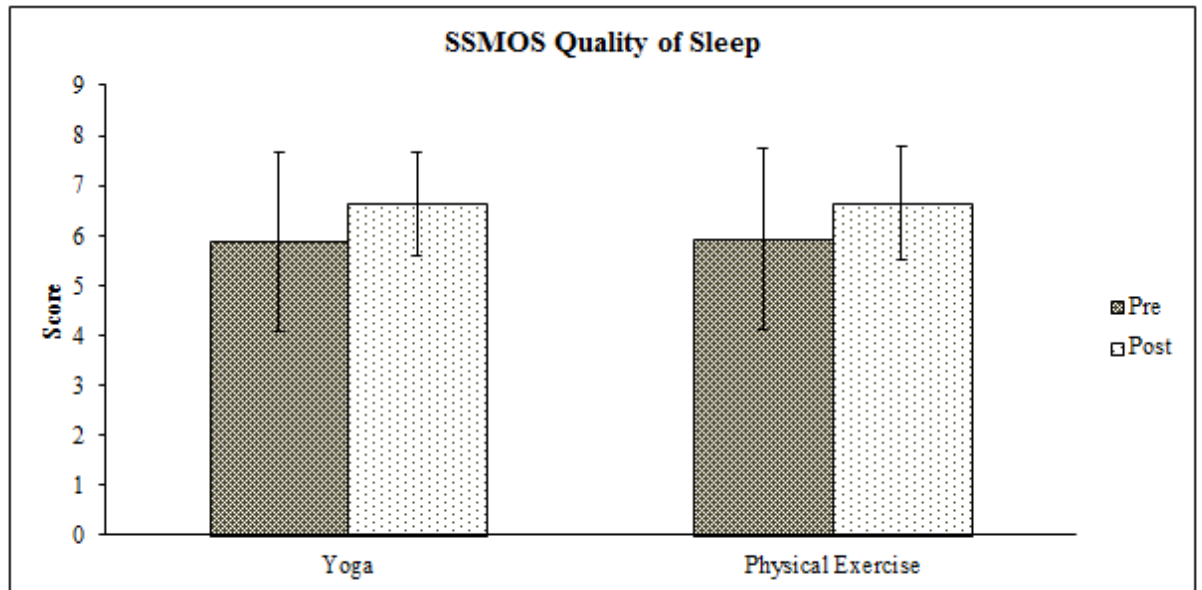
Comparison of SSMOS Sleep Awakening between the Yoga & Physical groups (Mean \pm SD) [PIC 20]



**Comparison of SSMOS Sleep Adequacy between the Yoga & Physical groups
(Mean \pm SD) [PIC 21]**



**Comparison of SSMOS Quality of Sleep between the Yoga & Physical groups
(Mean \pm SD) [PIC 22]**



CHAPTER 7

7.0 Discussion

To our knowledge, this is the first two arm parallel group randomized comparative clinical study evaluating the add-on effect of yoga and physical exercise on cognitive function, motor function and psychological well beings among people with substance abuse problem. The participants were recruited from a rehabilitation center which provides therapeutic environment for detoxification to SUDs.

7.1 Findings of the current study

Tasks of cognitive function, including selective attention, response inhibition, and working memory are major important risk factors for recovery and relapse for SUDs. The findings of the unblinded treatment and blinded outcome assessment study of 12 weeks period suggest that add-on yoga or physical exercise-based intervention achieved significant enhancement in response inhibition, immediate memory span, working memory, and sustained and selective attention. Improvements due to yoga and physical exercise were not significantly different. Tasks of motor function, including fine motor speed, dexterity, and arm-hand steadiness observed significant impairment in SUDs. Further, the present study has demonstrated 12 weeks of yoga, or physical exercise training in addition to conventional therapies producing substantial recovery of motor function in substance abuser in a residential rehabilitation center. Enhancements due to yoga and physical exercise were not significantly different. Furthermore, the current study demonstrates 12 weeks of yoga, or physical exercise training in addition to standard therapies produces considerable with-in group enhancement of psychological wellbeing and major domain of sleep in substance abuser in a residential rehabilitation

center. Further, the mindfulness component of the wellbeing has shown enhancement following add-on yoga group, not with exercise. Furthermore, the augmentations due to yoga and physical exercise were not significantly different between groups.

7. 2 Comparisons with previous studies

Our results are in line with previous studies which suggest, the increase in cognitive function following a yoga and exercise-based intervention (Barnes, 2015; Gothe, Keswani, & McAuley, 2016; Gothe, Kramer, & McAuley, 2014; Moore & Malinowski, 2009; Suzuki et al., 2013). Recent study has shown a high level of physical activity as a significant protection against cognitive decline (Barnes, 2015). Further, this is consistent with a study of home-based exercise intervention showing similar improvement in global cognitive measures for subjects at risk for cognitive decline (Suzuki et al., 2013). Yoga-based techniques have demonstrated the positive influence on neuropsychological functions such as selective and executive function (Gothé, Kramer, & McAuley, 2014). Furthermore, results imply a positive effect, especially on attention, memory, verbal fluency, and cognitive flexibility (Moore & Malinowski, 2009). The results are consistent with previous studies that demonstrated enrichment of motor function such as strength, dexterity, speed, flexibility, gait, and steadiness following yoga and physical exercise-based intervention in healthy adults (Dash & Telles, 1999; Mills, 1994; Subramaniam & Bhatt, 2017), the elderly population (Cadore, Rodríguez-Mañas, Sinclair, & Izquierdo, 2013; Kavanagh, Wedderburn-Bisshop, & Keogh, 2016; Kwok, Choi, & Chan, 2016), and in patients (Dalgas et al., 2009; Quaney et al., 2009; Tekur, Singphow, Nagendra, & Raghuram, 2008). Self-

control has shown a buffering impact impact (Wills, Ainette, Stoolmiller, Gibbons, & Shinar, 2008), on the risk factors among persons with substance, the current result is in line with previous studies shown foster self-control following yoga (Friese, Messner, & Schaffner, 2012), and exercise (Oaten & Cheng, 2006). Interesting with-in group result shown enhancement of mindfulness, the present moment awareness following add-on yoga not with exercise. This may be due to the emphasis on breath regulation, mindfulness during training, and the importance given to the holding of postures which differentiates yoga practices from physical exercises (Govindaraj, Karmani, Varambally, & Gangadhar, 2016). An emerging results highlight Substance use disorders endured a strong association with depression and anxiety outcomes and appears more attributable to the comorbidity of SUDs (Compton, Thomas, Stinson, & Grant, 2007; Davis, Uezato, Newell, & Frazier, 2008). Current result shown a significant with-in group reduction of depression and anxiety following yoga and exercise. The result was concordance with previous study shown decrease in psychiatric symptoms along with an enhancement in positive psychosocial outcomes, following yoga based intervention (Bowen et al., 2006), and exercise (Barbour, Edenfield, & Blumenthal, 2007). Further, sleep disturbances have an influential role in the initiation, maintenance, and relapse in substance use disorder (Roehrs & Roth, 2015) and it persists even after weeks or years of withdrawal (Conroy & Arnedt, 2014). The results conforming with studies shown the effect of yoga (Britton et al., 2010) and exercise (Youngstedt, 2005) on sleep. While the snoring domain of the sleep index has not shown any difference, this may be subjective quantified methods to measure snore may

not a valid measure, audio analysis approach may enable systematic detection of snoring sounds and more accurate measure.

7.3 Possible Mechanism

Use of illicit substance was linked to structural brain changes with consistent reports of hippocampal volume deficits, which alter cognitive function (Filbey, McQueeney, Kadamangudi, Bice, & Ketcherside, 2015; Sullivan, Marsh, Mathalon, Lim, & Pfefferbaum, 1995). Exercise training has good impact at recovering hippocampal volume loss in late adulthood, which was accompanied by an improved memory function (Erickson et al., 2011). Further, a pilot study on yoga intervention as an add-on lifestyle practice on elderly adults has shown increment in the volume of the bilateral hippocampus (Hariprasad, Varambally, et al., 2013). Reversing of hippocampal volume may be a potential mechanism by which practice of exercise or yoga enhanced cognitive function among SUDs. Further, Dopamine (DA) is a neurotransmitter that is essential in regulating brain processes connected with motor function (Volkow et al., 2000). Previous results provide evidence that substance abuse at dose levels and long-term leads to reductions in the brain dopamine transporter, associated with significant motor function impairment (McCann et al., 1998; Wilson et al., 1996). Further, the results emphasize, interventions that enhance dopamine activity may improve motor performance irrespective of age (Volkow et al., 1998). There is an initial finding from a yoga-based intervention that showed an increased release of dopamine (Kjaer et al., 2002). Furthermore, preliminary results demonstrate that substance abuse induced deficits in the dopamine system are reversible in human subjects, and exercise training can facilitate the process (Robertson et al., 2016).

Increased endogenous dopamine release may be a potential mechanism by which practice of exercise or yoga enhanced motor function among SUDs. Further, the yoga-based intervention has demonstrated significant stress-reduction on psychological and physiological indices of stress among SUDs (Brewer et al., 2009). Furthermore, a recent review has highlighted moderate and high-intensity aerobic exercises, and the mind-body interventions can be an effective and sustainable treatment for those with SUDs (Wang et al., 2014). The possible mechanism may be increased in core body temperature (Petruzzello, Landers, Hatfield, Kubitz, & Salazar, 1991), or changes in cortical activity following practice (Kubitz & Landers, 1993). Further may be the training weakened the subjective experiences of craving (Witkiewitz, Marlatt, & Walker, 2005), and reduced stress-related outcomes (Garland, Boettiger, Gaylord, Chanon, & Howard, 2012; Zgierska, A; Rabago, D; Chawla, N; Kushner, K; Koehler, R; Marlatt, 2009). The methodological shortcoming of this study was the lack of a control group, hovering the likelihood that the detected effects are not due to the interventional program by itself, but echo normal recovery due to 12 weeks of sobriety. Research should access to brain imaging or biochemistry, so that the potential physiological mechanisms could be identified.

7.4 Conclusion

The current study is, to our information, the first randomized, comparative, active control design to evaluate the effect of the yoga-based intervention on cognitive function, motor functions and psychological wellbeing in SUDs. This is the initial study where yoga and physical exercise assessed with subjective and objective outcomes among SUDs. Viability of rigorous overseen module of yoga and physical exercise in

SUDs was established. The study provided the empirical indication for promoting and endorsing yoga and physical exercise for substance use as a cost-effective module for enhancing the psycho-motor cognitive state of substance abusers. The clinical application of findings is significant, as the improved psycho-motor function and cognitive conditions will be a facilitating factor in promoting well-being and inhibition of relapse.

Our results recommend that the add-on yoga or exercise-based intervention has shown an augmentation of cognitive functions, motor functions and psychological wellbeing. Yoga seems to be as good as physical exercise. The clinical implication of conclusions is noteworthy, as enhanced cognitive functions linked to executive function domains will be a mediating factor in endorsing wellbeing and prevention of relapse. Further, stumbling and uncoordinated motor functions quelled with sobriety, as the enhanced motor function will be a supplementing factor in promoting wellbeing. Furthermore, as the enhanced of psychological wellbeing will be a helping factor in dropping the craving and averting of relapse. Rigorous trials are obligatory to explore the long-term effect and its practical application in the relapse prevention and to estimate the underlying mechanisms. Furthermore, the research should explore whether integrating yoga and physical exercise would lead to more synergic benefits than yoga or physical exercise alone.