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RESEARCH ARTICLE

Influence of Exercise in the Absorption of Vitamin D among Professional Athletes with Deficiency or Insufficiency of Vitamin D Levels in the State of Kerala

Vijay Selvan N*, Arunachalam Ramachandran[2] and Althaaf Mohamed A.H[3]

[1]PhD Scholar, Department of Physiotherapy, Madhav University, Abu Road, Rajasthan, India.
[2]Professor and HOD, Department of Physiotherapy, KMCT College of Allied Health Sciences, Kozhikode, Kerala, India.
[3]Professor and HOD, Department of Physiotherapy, Madhav University, Abu Road, Rajasthan, India.
[4]Chief Orthopaedic Surgeon at the Knee Joint, CEO and Managing Director of Health Street Hospitality LLP, Managing Director of Surecell in India LLP, Kerala, India.

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*Address for Correspondence:
Vijay Selvan N
Department of Physiotherapy,
KMCT College of Allied Health Sciences,
Kozhikode, Kerala, India.
Email: vijnat@yahoo.com

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ABSTRACT

The Vitamin D levels are most independent of many of the factors that were considered to be influencing the serum Vitamin D levels. This gave birth to a new ideology about the behaviour of the serum Vitamin D levels among different nationals. The present study was done to find the influence of "High Intensity Vigorous Exercise Protocol [HIVE - Protocol]" in the absorption of Vitamin D among Vitamin D deficient and insufficient athletes from two districts of Kerala state. 72 subjects were randomized in to two groups with 37 patients were allotted to group A and 35 to group B. 3 Sports Academies in the districts of Malappuram and Kozhikode (4 each) were taken into study. Routine Conventional Sports Specific Exercise Training Program are administered for both the groups and the Specially designed "High Intensity Vigorous Exercise Protocol [HIVE - Protocol] is administered to the group B alone. 25-Hydroxy Vitamin D levels and SF-12-Quality of life scale (SF-12-QOL) were used as outcome measures. The distribution of 25(OH) D between the groups didn't show any significant difference between the groups. The within group analysis of group A and group B shows significant difference between the pre-test values and post-test values for SF-12- PCS score, whereas SF-12- MCS values shows no significant difference in group A. Vitamin D values within group A and group B shows significant difference between the pre-test values and post-test values. Both group A intervention and group B intervention were effective in improving the quality of life and Vitamin D levels among athletes. Group B intervention

has a marginal advantage over group A in terms of improvement in 25-Hydroxy Vitamin D levels and mental health in quality of life.

Keywords: Vitamin D, athletes, 25-Hydroxy Vitamin D levels, SF-12-Quality of life scale, HIVE Protocol

INTRODUCTION

The Vitamin D levels are most independent of many of the factors that were considered to be influencing the serum Vitamin D levels [1]. This gave birth to a new ideology about the behaviour of the serum Vitamin D levels among different nations. On the other hand the athletes are also not aware about the various causes of Vitamin D deficiency [2,3]. They are not aware about the fact that Vitamin D deficiency can cause generalised body pain and there by influence the performance level [4]. Previous studies showed that more professional athletes were very concerned about vulnerability to skin cancer risk when exposed to sun than the concern about their Vitamin D status when not exposed to sunlight [5]. Yet despite this serious concern of skin cancer, most of the athletes' practise in the sun, but they heavily depend on the sun screen lotions for protecting the skin form UVR which they consider the major risk factor for their risk of skin cancer. The important thing to note here is the risk of Vitamin D deficiency in doing so is also a potential problem which may end their career though not abruptly but insidiously and steadily [6]. In the experience of the primary researcher in educating the athletes on Vitamin D requirements there are lots of unanswered questions raised by the audience which needs to be attested by research. The major question would be pertaining to the source of Vitamin D, signs and symptoms of Vitamin D deficiency and monitoring systems in Vitamin D. All these questions can be answered with accuracy and validity. But there are few questions we felt challenging are been taken as objective in the current study. The major questions the athletes raise in such orientation classes is, what exercises should be adopted to improve Vitamin D absorption, can exercise impact Vitamin D absorption, can Vitamin supplements with specific exercises impact the Serum Vitamin D levels more compared to supplements and conventional training, how the effect of supplementation will decay over a period of time after the stoppage of the Vitamin D supplementation. We compiled this entire question as a research problem and framed the research question based on the problem thus obtained. The Aim of this study was to find the influence of "High Intensity Vigorous Exercise Protocol [HIVE - Protocol]" on the absorption of Vitamin D among Vitamin D deficient athletes from two districts of Kerala state.

METHODOLOGY

The athletes were recruited from 8 sports academies. 97 subjects who fitted into the inclusion and exclusion criteria were taken into study and assessed for Vitamin D deficiency and insufficiency. And out of 97 subjects assessed 73 were found to be insufficient / deficient in vitamin D levels 73 subjects were randomly allotted to Group A and B. Allocation ratio was 1:1 where 37 patients were allotted to group A and 36 to group B. Subjects who were not willing to adopt the exercises protocol, subjects who had an immediate approaching event or competition, Subjects who were not willing to take Vitamin D supplements were excluded from the study. 8Sports Academies in the districts of Kozhikode and Malappuram (4 each). All the subjects signed an informed consent in their convenient language either in Malayalam or English. The outcome measures used for the study were one objective biochemical and another subjective a quality of life scale [7]. They were 25-HydroxyVitamin D levels and SF-12-Quality of life scale (SF-12 QOL). (7) As a fasting specimen was recommended, the athletes gave a fasting blood sample. The SF-12 QOL Questionnaire were analysed for the subjects by providing them the online assessment link "https://orthotoolkit.com/sf-12/" which they were asked to perform at their own place with their mobile or laptop/ desktop through the link which is being provided to them and forward the same to the primary researcher's E-Mail ID with mention of their specific allotted code number. The study consists of two important steps: generating an unpredictable random sequence and followed by implementing the sequence in a way that conceals the treatments until patients have been formally assigned to either of the groups. Methods of generating a random allocation

sequence indicate using a random numbers table method that generates the random sequence. Sequentially numbered, opaque, sealed envelopes were used for concealment. The data feeder of SF-12 QOL score was blinded. A person who was not part of the intervention was used as data feeder to enter the SF-12-QOL score values directly into the master chart to avoid data manipulation and human error. Routine Conventional Sports Specific Exercise Training Program are administered for both the groups and the Specially designed "High Intensity Vigorous Exercise Protocol [HIVE- Protocol] as detailed in Appendix I, is administered to the group B alone.

Statistical Methods

The statistical data for the study were analysed using SPSS software. The significance level was fixed as 0.005 at a confidence interval of 95% for all the group analyses. Between groups analysis for parametric data were performed using independent t test and for non-parametric data Mann Whitney Test was done. For the within group analysis of non-parametric data Wilcoxon Signed Ranks Test was used and Paired t test was used for parametric data. Chi Square analysis was used find the homogeneity among groups in terms of demographic data.

RESULTS

Participant flow chart in Figure 1 shows subjects in each group, the numbers of participants who were randomly assigned, received intended treatment and were analysed for the primary outcome. There were only 3 temporary drop outs from the groups after the intervention had commenced, two subjects were from group A[1 relocated and other had malaria] and one subject from group B [grade I ankle injury (Lateral ligament)]. The primary researcher did not resume the intervention immediately for the latter two subjects as he felt these data will contaminate the study results. Hence the subjects with malaria and ankle injury who dropped for a brief period momentarily, started training after 25 days of proving their fitness. Table 1 shows the baseline demographic characteristics for each group. The distribution of 25 (OH) D between the groups didn't show any significant difference between the groups with the chi square statistic value of 0.023 and a p-value of 0.991.The between group analysis of the SF 12 QOL Questionnaire was dealt with two parts SF-12- MCS and SF-12- PCS. The non parametric analysis was performed to assess SF-12- PCS values which revealed that there was a significant difference between the group A and B with group A having a better scores with a mean rank value of 42.44 compared to 30.56 of group B with a p value of 0.016. Table 2 shows the between group analysis of Ranks for the pre-test values of SF-12- PCS and Table 3 shows the between group analysis of Test Statistics for the pre-test values of SF-12- PCS. The analysis of SF-12 - MCS values revealed that there was a significant difference between the group A and B with group A having a better scores with a mean rank value of 44.80 compared to 28.17 of group B with a p value of 0.001. (Table 2& 3).The analysis of Vitamin D revealed that there was no significant difference between the group A and B with a mean value of 23.38 compared to 23.71 of group B with a p value of 0.888. (Table 4 & 5).

Between Group Analysis of Post-Test Values of SF-12- PCS and MCS and Vitamin D

The Graphical representation for between Group Analysis of Pre and Post Mean Values of SF-12 PCS and MCS and Vitamin D levels are shown in Figure 2.The non parametric analysis was performed to assess post test values of SF-12- PCS which revealed that there was no significant difference between the group A and B with a mean rank value of 40.79 compared to 32.21 of group B with a p value of 0.092. The non parametric analysis was performed to assess post test values of SF-12- MCS which revealed that there was no significant difference between the group A and B with a mean rank value of 33.82 compared to 39.18 of group B with a p value of 0.277. The parametric analysis between the group was performed to assess post test values of Vitamin D values which revealed that there was no significant difference between the group A and B with a mean value of 37.86(3.9) compared to 40.45(3.9) of group B with a p value of 0.820 as detailed in Table 4and Table5.

Within Group Analysis of Group A: The Graphical representation for Within group Mean Values of Pre, Post and Follow up SF-12 PCS, MCS and Vitamin D in Group A are shown in Figure 3. The within group analyses of group A

shows that There was a significant difference between the pre-test values and post test values for SF-12- PCS score with a Z score of -5.286 and a P value of 0.001. Table 6 shows the within group analysis of Ranks in Group A for SF-12- PCS values and Table 7 displays the within group analysis of Test Statistics in Group A for SF-12- PCS values. The within group analysis for SF-12- MCS values of group A shows that there was no significant difference between the pre-test values and post test values Z score of -0.475 and a P value of 0.635. Table 8 shows the within group analysis of Ranks in Group A for SF-12- MCS values and Table 7 shows the within group analysis of Test Statistics in Group A for SF-12- MCS values. The within group analysis for Vit D values of group A shows that there was a significant difference between the pre-test values and post-test values T score of -11.318 and a P value of 0.001. Table 8 shows the within group analysis of Paired Sample Statistics in Group A for Vit. D values, Table 9 shows the within group analysis of Paired Sample Correlations in Group A for Vit. D values and the Table 9 shows the within group analysis of Paired Sample Test in Group A for Vit. D values.

Within Group Analysis of Group B: The Graphical representation for Within group Mean Values of Pre, Post and Follow up SF-12-PCS, MCS and Vitamin D in Group B are shown in Figure 4. The within group analysis of group B shows that There was a significant difference between the pre-test values and post test values for SF-12- PCS score with a Z score of -5.153 and a P value of 0.001. Table 5 shows the within group analysis of Ranks in Group B for SF-12- PCS values and Table 7 displays the within group analysis of Test Statistics in Group B for SF-12- PCS values. The within group analysis for SF-12- MCS values of group B shows that there was a significant difference between the pre-test values and post test values Z score of -2.891 and a P value of 0.004. Table 6 shows the within group analysis of Ranks in Group B for SF-12- MCS values and Table 7 shows the within group analysis of Test Statistics in Group B for SF-12- MCS values. The within group analysis for Vit. D values of group B shows that there was a significant difference between the pre-test values and post-test values T score of -41.809 and a P value of 0.001. Table 8 shows the within group analysis of Paired Sample Statistics in Group B for Vit. D values, Table 9 shows the within group analysis of Paired Sample Correlations in Group B for Vit. D values and the Table 9 shows the within group analysis of Paired Sample Test in Group B for Vit. D values.

DISCUSSION

This study aimed to find the influence of exercise in the absorption of Vitamin D among athletes from two different districts of Kerala namely Kozhikode and Malappuram. The athletes selected were identified with Vitamin D deficiency through a previous cross sectional study. The main objective of the study was to find the effect of Vitamin D supplements and routine conventional sports specific exercise training program in the absorption of serum Vitamin D and quality of life among the athletes from these two States. The next objective was to find the effect of Vitamin D supplementation and specifically designed exercise program for this study which was named as "High Intensity Vigorous Exercise Protocol [HIVE - Protocol]" and conventional sports specific exercise training program in the absorption of Vitamin D level and also to find the quality of life among athletes with Vitamin D deficiency from these two selected states of Kerala. And finally the study also had an objective of comparing the effect of Vitamin D supplements between routine conventional sports specific exercise program and the "High Intensity Vigorous Exercise Protocol [HIVE - Protocol]" which was specifically designed for the study. Results of the study showed that both the group was highly homogenous. It was proved by the baseline values of both the groups and also the demographic data of both the groups. In the demographic data analysis there was no significant difference between both the groups in terms of sex distribution, age distribution, games involved, practice area, years of experience, hip-waist ratio, BMI distribution and Vitamin D levels. Hence for any changes in the variable relationship demographic data would have not been responsible.

Secondly, the baseline analysis of the outcome measures for both the groups was done which show that there was no significant difference between the Vitamin D values in both groups at the start of the intervention. However there was a significant difference between the SF-12- MCS and SF-12- PCS values which was really marginal. It can be argued that with all other parameters having no significant difference, the difference that existed between the

nonparametric scales can be considered as negligible as not significant. The between group analysis of the post test values of both the groups show that there was no significant difference between the group A and group B for SF-12- PCS value and SF-12- MCS value. In the analysis of the Vitamin D there was no significant difference between group A and group B with group B scoring more than group A [B]. In the within group analysis of group A there was a significant difference between the pretest and post test values for SF-12- PCS scores, but there was no significant difference between the SF-12- MCS values in group A. Within group analysis of group A Vitamin D level show that there was a significant difference between the pre-test and post test values. In the within group analysis of group B there was a significant difference between the pre-test values and post-test value for SF-12- MCS and SF-12- PCS values. And also there was a significant difference existed in the Vitamin D levels. This clearly states that group B intervention has a superior effect over the group A. To sum up between group values did not show much difference between the group A and group B but the within group difference was better for group B compared to group A. This was consistent to previous study results [9,10,11].

CONCLUSIONS

From this study it is concluded that both group A intervention and group B intervention were effective in improving the quality of life and Vitamin D levels among athletes. Group B intervention has a marginal advantage over group A in terms of improvement in Vitamin D levels and mental health in quality of life. It is also concluded from this study that with only marginal difference existing between the two interventions in short term, it is always advisable to go for a long term benefit analysis to find out the retain ability of the improvement gained through both the intervention protocol.

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Table 1: Baseline demographic characteristics and Vitamin D level

Characteristics	Group A	Group B
No of subjects allotted	37	36
Age (Mean & SD)	21.78(4.7)	21.08(3.4)
Sex ratio	Male:21 Female:16	Male:27 Female: 9
Games	Football - 28 Cricket - 1 Volley ball - 3 Track event - 3 Field event - 4	Football - 25 Cricket - 3 Volley ball - 6 Track event - 1 Field event - 3
Practice area	Outdoor – 35 Indoor – 2	Outdoor – 36 Indoor - 0
Years of experience	6.59 (3.5)	6.05 (2.5)
H/W Ratio	Waist - 31.45(3.2) Hip -37.08(3.5) Ratio - 0.8(0.1)	Waist - 32.13(2.03) Hip - 37.86(2.9) Ratio - 0.85(0.05)
BMI	163.22(8.56) 62.89(9.42) 23.6(1.17)	164.81(6.4) 63.58(4.8) 23.39(1.2)
25(OH)D ng/mL	23.38 (4.3)	23.71(4.4)

Table 2: Between group analysis of Ranks for SF-12 Scores

	SF-12 – PCS				SF-12 – MCS			
	Pre Test		Post Test		Pre Test		Post Test	
	Group A	Group B	Group A	Group B	Group A	Group B	Group A	Group B
N	37	36	37	36	37	36	37	36
Mean Rank	42.44	30.56	40.78	32.31	46.85	26.17	39.82	34.18
Sum of Rank	1628	1100	1485.5	1163.5	942	1688	1217.5	1413.5

Table 3: Between group analysis of Test Statistics for SF-12 Scores

	SF-12- PCS		SF-12- MCS	
	Pre Test	Post test	Pre Test	Post test
Mann Whitney U	434	493.5	278	581.5
Wilcoxon W	1100	1163.5	942	1217.5
Z	-2.41	-1.741	-4.19	-1.087
Asymp. Sig. (2-tailed)	0.016	0.082	0	0.277

Table 4: Between group analysis of Vitamin 'D' Level

	Pre Test		Post Test	
	Group A	Group B	Group A	Group B
N	37	36	37	36
Mean	23.3810	23.7111	37.3694	40.4656
Std. Deviation	4.32767	4.49277	3.97174	3.90866
Std. Error Mean	0.71150	0.7488	0.65296	0.65111

Table 5: Between Group Independent Samples Test for Vitamin 'D' levels

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Pre Vitamin D	Equal variances assumed	0.162	0.688	-0.416	70	0.679	-0.4333	1.04143
	Equal variances not assumed			-0.416	69.919	0.679	-0.4333	1.04143
Post Vitamin D	Equal variances assumed	0.052	0.82	-2.678	70	0.009	-2.4861	0.92851
	Equal variances not assumed			-2.678	69.981	0.009	-2.4861	0.92851

Table 6: Within Group Analysis of Ranks for SF-12 Scores

	Group A - Pre and Post SF-12				Group B - Pre and Post SF-12			
	PCS Rank		MCS Rank		PCS Rank		MCS Rank	
	Negative	Positive	Negative	Positive	Negative	Positive	Negative	Positive
N	1	36	19	18	2	34	24	12
Mean Rank	1	19.5	18.84	21.28	2.5	19.44	21.94	12.42
Sum of Ranks	1	702	358	383	5	661	527	149

Table 7: Within group Test Statistics for SF-12 Scores

	Group A -Pre and Post SF-12		Group B -Pre and Post SF-12	
	PCS	MCS	PCS	MCS
Z	-5.286	-0.475	-5.153	-2.891
Asymp. Sig. (2-tailed)	0	0.635	0	0.004

Table 8: Within Group Paired Samples Statistics of Vitamin'D' Level

Group	Vitamin D	Mean	N	Std. Deviation	Std. Error Mean
A	Pre Test	23.361	37	4.32787	0.71152
	Post Test	37.389	37	3.97174	0.66196
B	Pre Test	23.711	36	4.40277	0.7488
	Post Test	40.456	36	3.90096	0.65111

Table 9: Within Group Paired Samples Correlations for Vitamin 'D' levels

Group	Vitamin D	N	Correlation	Sig.	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		T	Df	Sig. (2-tailed)
								Lower	Upper			
A	Pre & Post	37	0.312	0.06	-13.562	7.208	1.185	-15.982	-11.132	-11.32	36	0
B	Pre & Post	36	0.865	0	-16.744	2.402	0.405	-17.557	-15.931	-41.81	35	0

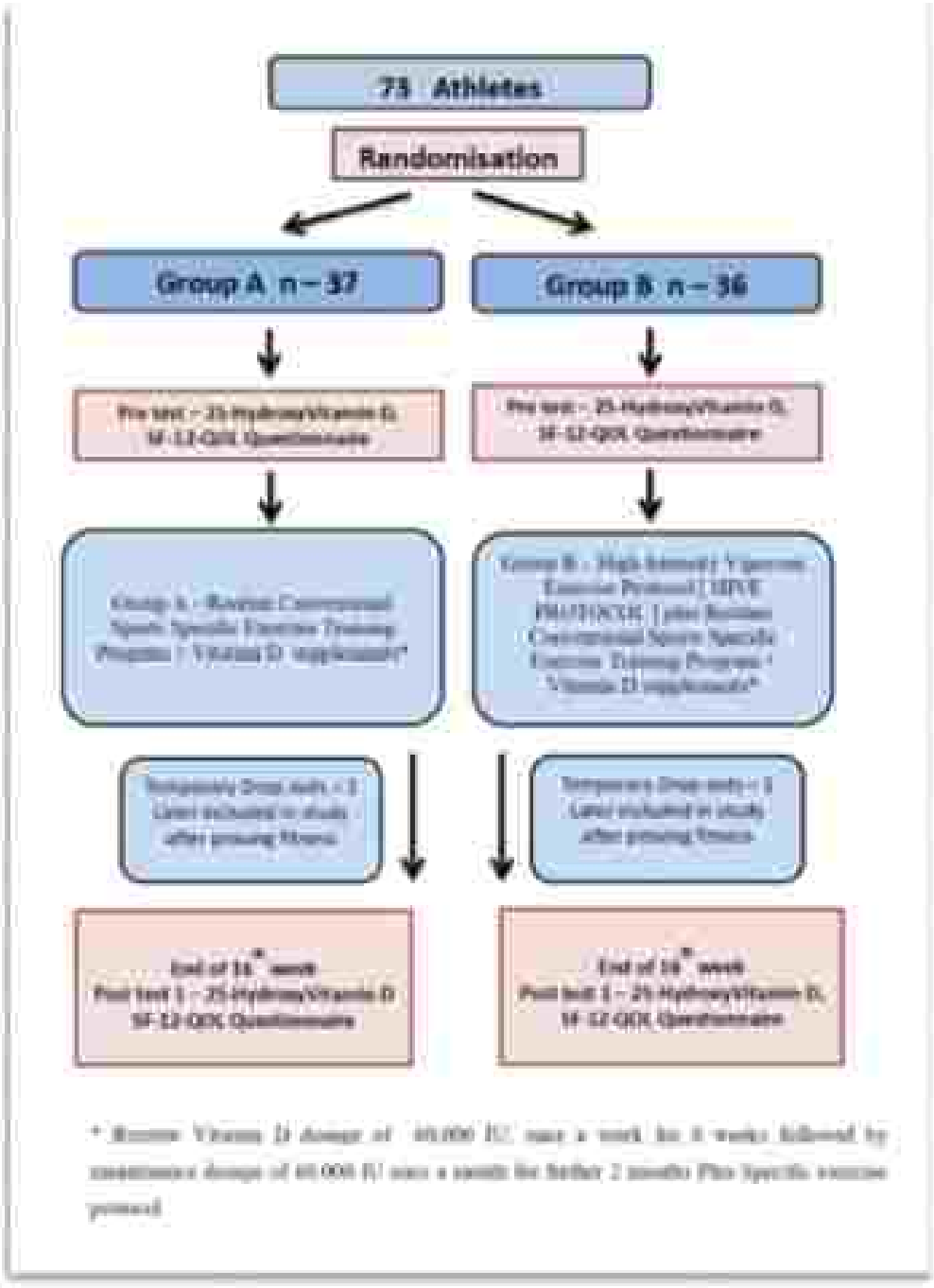

Figure 1: Flow chart of Methodology

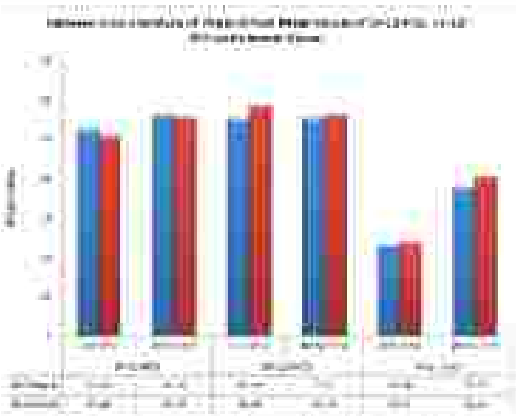

Figure 2: Graphical representation for Between Group Analysis of Pre and Post Mean Values of SF-12-PCS, SF-12-PCS and Vitamin D level

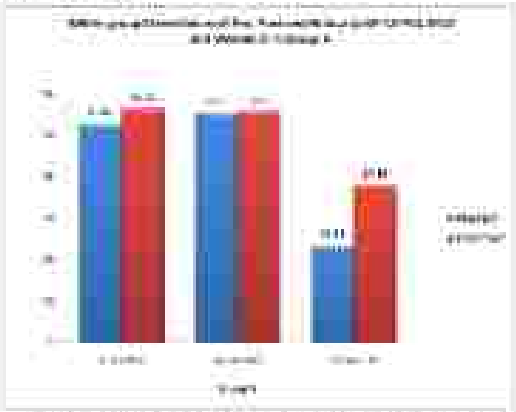

Figure 3: Graphical representation for Within group Mean Values of Pre and Post SF-12-PCS, MCS and Vitamin D in Group A

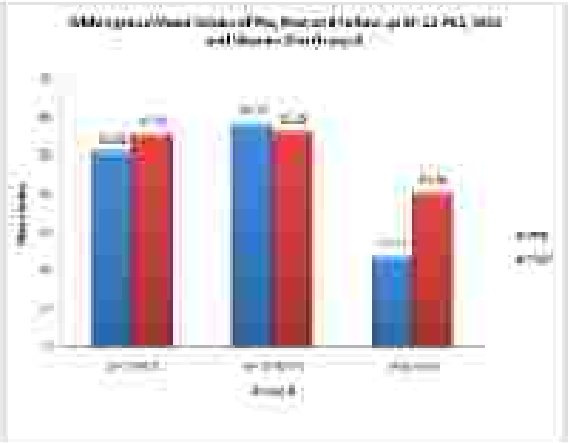

Figure 4: Graphical representation for Within group Mean Values of Pre and Post SF-12-PCS, MCS and Vitamin D in Group B

SPECIALLY DESIGNED "HIGH INTENSITY VIGOROUS EXERCISE PROTOCOL" [HIVE PROTOCOL]

A. Tabata Workout - Total Workout Time: 35 Minutes

Includes 4 Tabata sets, each with two high-intensity exercises the athletes will alternate for the length of each set. Longer rests if needed can be taken.

Warm-up: 10 minutes cardio, gradually increasing intensity

Tabata Set 1:
1. Burpees
2. Mountain Climbers

Alternate every exercise for 20 seconds with resting 10 seconds between each and repeat the same for 8 cycles
Resting time of 1 minute after this set

Tabata Set 2:
1. Long Jumps
2. Plyo-Jacks

Alternate every exercise for 20 seconds with resting 10 seconds between each and repeat the same for 8 cycles
Resting time of 1 minute after this set

Tabata Set 3:
1. Squat Jumps
2. Jogging - High Knees

Alternate every exercise for 20 seconds with resting 10 seconds between each and repeat the same for 8 cycles

Resting time of 1 minute after this set

Tabata Set 4:
1. Jump Kicks
2. Side to Side Jumping Lunges

Alternate every exercise for 20 seconds with resting 10 seconds between each and repeat the same for 8 cycles
Resting time of 1 minute after this set then Cool down: 5 minutes

Appendix I: HIVE Protocol

B. **Dumbbell Workout - All out high power HIIT program** - Total exercise time - 15 mins

Close Grip Chest Press - 30 seconds
Close Grip Chest Press with Crunch - 45 seconds

Close Grip Chest Press along with Crunch and incorporating with Leg Lowers - 75 seconds

Squat Hold - 45 seconds

Renegade Rows - 30 seconds

Weighted Walkout through to Renegade Row - 45 seconds

Weighted Walkout through to Renegade Row and then Knee Raise and Twist - 75 seconds

Squat Hold - 45 seconds

Dumbbell Over the Shoulder Chops - 30 seconds

Squat and to Over the Shoulder Chops - 45 seconds

Squat Thrust and to Over the Shoulder Chops - 75 seconds

Cool down Stretch - 45 seconds

C. **The Total Body Breakdown** - Set a timer for 12 minutes

Done as an "every minute on the minute" - EMOM circuit training. So the athletes will have one minute to do each move, then they will rest until the start of the next minute. The faster they finish their reps, the more time they would get to rest.
Minute 1: 15 air squats

Minute 2: 15 burpees

Minute 3: 10 lying Superman holds

Repeat this 3 minute EMOM circuit for 4 times.

Total HIVE Protocol Timing : 15x15x12 = 62 Minutes

Done 3 times a week as evening workout for the entire Intervention (4 Months)

Done 3 times a week as evening workout for the entire Intervention (4 Months)

1. Football Players – Tuesday/Thursday/Saturday * Every week
2. Cricket Players – Monday/Wednesday/Friday * Every week
3. Volleyball Players – Monday/Wednesday/Friday * Every week
4. Sprinters – Monday/Wednesday/Friday * Every week
5. Discus & Shot Put Throwers– Tuesday/Thursday/Saturday * Every week

Appendix I: HIVE Protocol [Contd.]