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Physiological Effect of Omega-3 Fatty Acid on Heart Rate Variability of Sub Elite Weightlifters: A Pilot Study

Hirak Jyoti Sarkar*

Master of Sports Physiology, Exercise Physiologist at Sanjeevini Life Care Village, Sports Complex, kerala India.

***Corresponding Author:** Hirak Jyoti Sarkar, Exercise Physiologist at Sanjeevini Life Care Village, Sports Complex, kerala India.*

E-mail: hirakjyotisarkar5@gmail.com

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ABSTRACT

***Aim of the Study:** To find the effect of omega-3 fatty acid on HR variability and R-R Interval. **Methods:** A 2-week randomized study was conducted. Participants are sub-elite weightlifters. All the subject was in pre-competition training. They have to perform 3 heavy sessions of 80%-85%, 85%-90%, and 90%-95% of the training load accordingly. Between the 2 weeks, one is considered the treated week and the other week consider a non-treated. In the treated week they provide recovery drinks immediately after the training which contained Flaxseed, Almonds, cashews, During Training, and Recovery HR variability and R-R interval were monitored through a GPS Heart rate monitor. Raisin. **Results:** There are no changes found between a treated and untreated week on Heart rate variability and R-R Intervals. **Conclusions:** Although Researcher told us Omega-3 helps to reduce HRV in the long-term study but in this investigation that is not found because the study was conducted over a short period.*

Keywords: Heart rate, Autonomous Nervous , Parasympathetic and Sympathetic, Myocardiocytes

INTRODUCTION

Recovery from exercise means the period between the end of an exercise and the return to the resting state. It is a dynamic period in which various physiological changes occur, after that simply returns to the pre-exercise state followed by exercise. In the cardiovascular system Heart rate is a marker of recovery. It seems that a person with good cardiovascular adaptation takes less time to recover from exercise. By constant monitoring of heart rate after exercise, it can be concluded. The whole purpose of recovery in exercise is to allow your muscles to repair themselves and to engage muscles that are sore from your workout. Different things can do during the recovery stage to help move the process along and come out ready to perform better than in the pre-test stage. Long-term adaptation to exercise training improved recovery. There are two modes of recovery-Active Recovery and Inactive recovery. Active recovery is a low-intensity exercise that must be performed after high-intensity exercise. Autonomic Contribution is important for recovery. Inactive recovery is associated with the action of the primary exercise stimulus from the brain (cerebral cortex-central command) which is responsible for the initial rapid drop in heart rate. Slower changes in the stimuli to mechanoreceptors and baroreceptors accompanying clearance of metabolites and delayed elimination of body heat and catecholamine are thought to be other factors contributing to heart rate recovery after physical activity. Less the heart rate more the athlete called to be recovered. As we know HRV and HR are correlated. If HR is less after exercise, then it can be said that HRV is on the normal side.

The beat of the healthy heart is not regular. It varies because of several factors such as respiration, blood pressure regulation, thermoregulation, actions of the renin-angiotensin system, circadian rhythms, and other unknown factors. Such variations of irregular beats of the heart are known as Heart rate variability. Several studies show that Omega-3 fatty acids might regulate HRV [1-3]. HRV is the variations between each heartbeat. In other words, the intervals between successive R waves (R-R). This variation is controlled by the Autonomous Nervous System (ANS). Data on HR Variability (HRV) may be useful for sports and the effects of training to determine the optimization of the physical state of an athlete because they reflect autonomic influences on the heart. The Heart Rate (HR) is a physiological parameter reflecting the autonomic regulation in the cardiovascular system. Autonomic regulation is the balance between the parasympathetic and sympathetic nervous systems. when the vagus nerve engages in activity it relays the message to the brain to suppress sympathetic response over a parasympathetic response which reduced the HR, as a result, HRV is increased, and when the vagus nerve disengages the sympathetic system is stimulated which increases HR and reduced HRV.

It is well known that nutritive supplements that can improve athletic performance and recovery. Ergogenic aids help an individual exercise and recover from exercise. Flaxseed is a plant-based food that provides fat which is good for health, antioxidants, and fiber. Flaxseed is used as a dietary supplement to prevent high cholesterol, heart disease, and cancer and contains Omega-3. Omega-3 has been recently considered as an ergogenic aid that may play a role in these processes, which helps in the health of muscle and its energy availability. Omega-3 is Polyunsaturated Fatty acid (PUFA) with more than one carbon-carbon double bond. One fatty acid is named is by according to the location of the first double bond which is counted from the omega (ω^-) or the n- end tail [1]. These essential nutrients have to can be found in fish such as sardines, salmon, tuna, and halibut. Among omega-3 flaxseed containing α-Linolenic Acid (ALA). Other two types of omega-3 are Eicosapentaenoic Acid (EPA), and Docosahexaenoic Acid (DHA). The study aims to see the effect of omega-3 on Heart rate variability and R-R interval at rest during training sessions and recovery after training.

LITERATURE REVIEW

Frederik *et.al* conducted a study where they gave a 3-hour dose of 0.6 g/kg body weight n3PUFA emulsion on 8 healthy subjects followed one week later by an oral administration of 0.6 g/kg over 3 consecutive days [1]. After 3 days of an oral supplement, Maximal power output, Maximal HR, and blood lactate were measured. It had been seen that both IV (after 3 days of oral supplements) and oral n-3PUFA significantly decreased maximal HR (-6% and -5%).

ikariyanto *et.al. 2020 shows that consuming almonds increases heart rate variability. In a study of men and women with an average CVD assigned in a 6-week randomized, controlled, parallel arm trial to consume either whole almond or control snacks (20% of daily estimated energy requirement). Five-minute periods of supine Heart Rate (HR) and HRV were measured at resting and during mental stress at baseline and six weeks [4].*

In another study Dikariyanto *et.al.* shows the beat-to-beat increase in HRV [5]. A total of 105 participants (73 females and 32 males; mean age 56.2 years,) completed the 6 weeks trial. Randomized control snacks (following the average UK snack nutrient profile), or dry-roasted whole almonds, both provide a 20% estimated energy requirement. Supine HRV was measured after resting.

In 4 months, a study by O Kafee *et.al.* in which 18 men with myocardial infarction and ejection fractions take part in this study [6]. They provided omega-3 fatty acids (585 mg of docosahexaenoic acid and 225 mg of Eicosapentaenoic Acid) after exercise showing the effect of omega-3 fatty acid on resting HR, recovery HR after exercise, and the result shows a decreased HR at rest, and improved 1 min recovery HR after 1min of exercise.

Leaf *et.al.* Found that 3 fatty acids can inhibit the fast, voltage-dependent sodium current and the L-type calcium currents in cultured Myocardiocytes. In heart cells, a resting membrane depolarization occurs in the Myocyte because of the fast movement of Na+ ions [7]. A sequential opening and closing of fast voltage-dependent sodium currents occur and ionic currents create action potentials in the Cardiomyocytes. Followed by outwardly directed potassium currents, move K^+ ions out of the cell and repolarization occur and the Myocyte back to its resting membrane potential. A plateau phase of action potential comes because of an inward calcium current, which temporarily delays repolarization. The orderly occurrence of these currents creates the action potentials, which couple the electrical and mechanical functions of the heart, resulting in its rhythmic contractions. Fatal arrhythmias occur when the electrical signals become chaotic and the heart can no longer function as a pump.

METHODS

Subjects

Four well-trained weight lifters, 1 male and 3 female volunteered to take part in this investigation. After completion of the training, the data saved in the sensor was collected in a CSV excel file for further analysis.

Before the investigation, participants gave their written consent on the purpose of the investigation and the potential risks to the subjects. None of the subjects didn't take any form of medication or alcohol during the study period. The subject's mean age was 20.7, mean height 158.25, and mean weight 80.375 respectively.

Training Protocol

All the subject was in pre-competition training and all the exercise was performed in a post-absorptive state (4 hours-5 hours after the last meal). They have to perform 3 heavy sessions of 80%-85%, 85%-90%, and 90%-95% of the training load accordingly. Training load was determined according to the body weight and gender of each subject. Each subject was instructed to perform snatch, clean and jerk, power snatch, power clean and jerk, front squat, and back squat according to their training protocol. The set and repetition were also different for each subject.

Monitoring of Heart rate Variability: Before the start of the training session pre-exercise heart rate was taken and noted down. Heart Rate variability was monitored during the hard training session (80%-95% training load) by using the Team Pro Polar Heart rate monitoring system for measurement of different physiological parameters (Heart Rate Variability, RRmax, RRavg, RRmin). Sensors were placed on the chest of all the subjects at the start of the training and changes in heart rate variability were monitored in a tab during the whole session. After completion of the training, the data saved in the sensor was collected in a CSV excel file for further analysis.

Nutritional Supplement Provide for the Experiment

The Recovery Drink which is given to the subject was verified by Central Food Technological Research Institute. Recovery Drinks was given to all subject for 7 days after completion of training for each day for further monitoring if there is any effect or not. This study was conducted for 2 weeks. 1st week was non-treated days (recovery drink was not provided to participants) and 2nd week (participants were given a recovery drink). In the meantime, there is no restriction on their training because they are in the pre-competition training phase and are advised to follow their training program as well as their diet plan also. The Recovery Drinks contain Omega-3 fatty acid which is mainly found in Flaxseed; other than Flaxseed there are Almond, Cashew, Raisin, Milkshake, and Sugar are also present. The composition of the recovery drink is detailed in the table below:

Aerobic capacity

Training demands are high for professional rugby league players, often training 5 days-6 days per week. These demands require high levels of fitness. It has been documented that, International players have an average VO2 max of (62.6 mL/kg/min) whilst players in the national competition are around (55.8 ml/k/min). Other studies in professional rugby league, have reported an estimated VO2 max of 48.6-56.4 mL/kg/min. Outside Back was found to have the highest score of (52.8 mL/kg/min) with backrowers and Props having scores of (51.1 mL/kg/min and 48.6 mL/kg/min) respectively. During the Nation Rugby League (NRL) competition players were shown to cover 6500 to 4500 meters per game. Outside backs covered the most distance running 6265 m ± 318 m, followed by adjustable distances of 5908 ± 158m a game. Hit-up forwards recorded the least distance during a game covering 4310 m ± 251m [8,9]. Hit-up forwards tend to be interchanged more often during games. Sometimes interchanging more than once per game, spending a mean time of 21 minutes per game on the bench. Meir et al, suggest that hit-up forwards require more interchangers because they are involved in more high-intensity efforts. Performing more hit-ups and tackles per game than other positional groups. These findings are supported by Coutts et al, reporting that blood lactate concentration in forwards is higher than in backs with 8.5mmol/L and 6.5mmol/l respectively during match day competition [10].

Speed

There are 3 stages of straight-line sprinting: acceleration, reaching maximum velocity, and speed endurance. Backs have been reported to be faster than other positions, one of the reasons is forwards are generally being heavier than their other counterparts (force=mass x acceleration). Conversely backs generally have space out on the edge of the field meaning they have a greater distance to reach higher speeds. Johnston et al reported that forwards ran the lowest distances at high speeds (513 m ± 298 m) followed by adjustable (907 m ± 255 m) with backs, running the most with (926 m ± 291 m) per game. Out of the total distance covered, athletes completed 75-95 high-intensity efforts in less than 10 meters. Only 1-3 runs were completed over 50 meters [11].

Sprinting efforts followed similar patterns with 40% of sprints being performed within 6-10 meters and 85% being less than 30 meters. Johnston et al. reported that only 1.4% of the sprints performed were classed as high-velocity efforts (7.0 ms^{-1}) with the remainder being acceleration efforts. Gabbett and King *et al*, found that there was no significant difference between backs and forwards over 10-meter efforts. However, backs and hookers were reported to be significantly faster over 40 m with reported sprint times of Centres (5.81 seconds), fullbacks (5.84 seconds), and hookers (5.88 seconds).

Repeat Sprint Ability

Rugby league is a high-intensity, intermitted based sport. Importance should be placed on the player's ability to perform repeated sprint efforts. According to the literature, repeated-sprint bouts are when three or more sprints are completed with less than 21 seconds of rest between each sprint. This seldom occurs in rugby league as players generally only perform 1 ± 1 (range 0-3) repeated-sprint bouts during a match. This suggests that repeat sprint ability does not necessarily replicate the most demanding passages of play during a match.

A paper done by Johnston et al, suggests that a more appropriate definition of Repeat High-Intensity Efforts (RHIE), should be used to quantify the most demanding passages of play. Similar to repeat sprint ability, RHIE is the ability to perform three or more high-intensity efforts with less than 21 seconds between each effort. It is suggested that the ability to perform these repeated high-intensity efforts could influence the outcome of a game as they tend to occur during crucial passages of play. Johnston *et al*, reported that players completed 9-14 bouts of repeated high-intensity efforts per game. The greatest frequency of bouts was performed whilst defending close to their try line (0 m-30 m). Over half (70%) of the repeated high-intensity efforts occurred within 5 minutes of a try being scored. Teams who completed more repeat high-intensity efforts were found to be more successful [12].

Agility

Throughout the literature, practitioners have described agility as any movement that involves a rapid change of direction. However, recent studies have described agility as a rapid change of direction in response to a sport-specific stimulus. Agility is a vital part of rugby league. Players are required to rapidly accelerate, decelerate, and change direction throughout a match. It has been reported; that backs are slightly better at agility than forwards with average L run times of 5.46 seconds for backs and 5.37 seconds for forwards. This is supported by Gabbett *et al*, reporting slightly faster times for backs during the Illinois agility test with mean times of 16.6 seconds, compared to 17.2 seconds for forwards.

Strength and Power

Strength and power are essential qualities in rugby league to be successful. Maximal strength and power, in both the upper and lower body, have been shown to increase as the playing quality rises. Furthermore, players need to be strong to get a quick play with the ball, or to make an effective tackle through an explosive leg drive. Multiple studies have reported that forwards were significantly more powerful than backs. O'Connor found that; props and back rows were significantly stronger than hookers, halves, and outside backs when performing a 3-repetition max (3 rm) (Table 1).

Table 1. Food content of recovery drinks

Food Content	Quantity	Energy (kcal)	Carbohydrate (gm)	Protein (gm)	Fat (gm)	Omega-3 Fatty Acid
Milk	180 ml	108	8.64	5.94	5.51	--
Flaxseed	8 gm	35.51	0.88	1.48	2.85	1036.48
Almond	10 gm	31	1.06	2.08	5.95	3.2
Cashew	5 gm	29.13	1.27	0.94	2.26	2.75
Raisin	15 gm	44.5	10.32	0.41	--	--
Sugar	16 gm	64	--	--	--	--
Total	234 gm	312.14	38.17	10.85	16.57	1042.43

Although forwards have greater absolute strength when compared to other playing positions. Research has found that relative strength is similar across all playing positions. It is suggested, that forward absolute strength is greater due to the demands of the position. Forward tend to perform more contact and collision-based activities. Meaning forwards require a higher absolute strength. Additionally, a study has reported significant strength and power differences between younger (<24 years) and older players (>28 years) with younger players having a stronger bench press and squat.

RESULT AND DISCUSSION

The resting, during, and recovery HRV and RR intervals were monitored and the mean value of 1st week and 2nd week of all parameters was analyzed. The mean value of Resting HRV of the 1st week and 2nd week was 21.33 milliseconds and 20.58 milliseconds were found. Similarly, the mean of HRV during training in the 1st and 2nd weeks is 14.92 milliseconds and 15.58 milliseconds respectively. Whereas, Recovery HRV of 1st and 2nd-week mean values are 20.33 milliseconds and 18.67 (Table 2).

Table 2 Mean value of HRV of Treated and Non treated week

	Resting HRV(milliseconds)	HRV During training (milliseconds)	RecoveryHRV (milliseconds)
1st week (non-Treated	21.33	14.92	20.33
2nd week(treated)	20.58	15.58	18.67

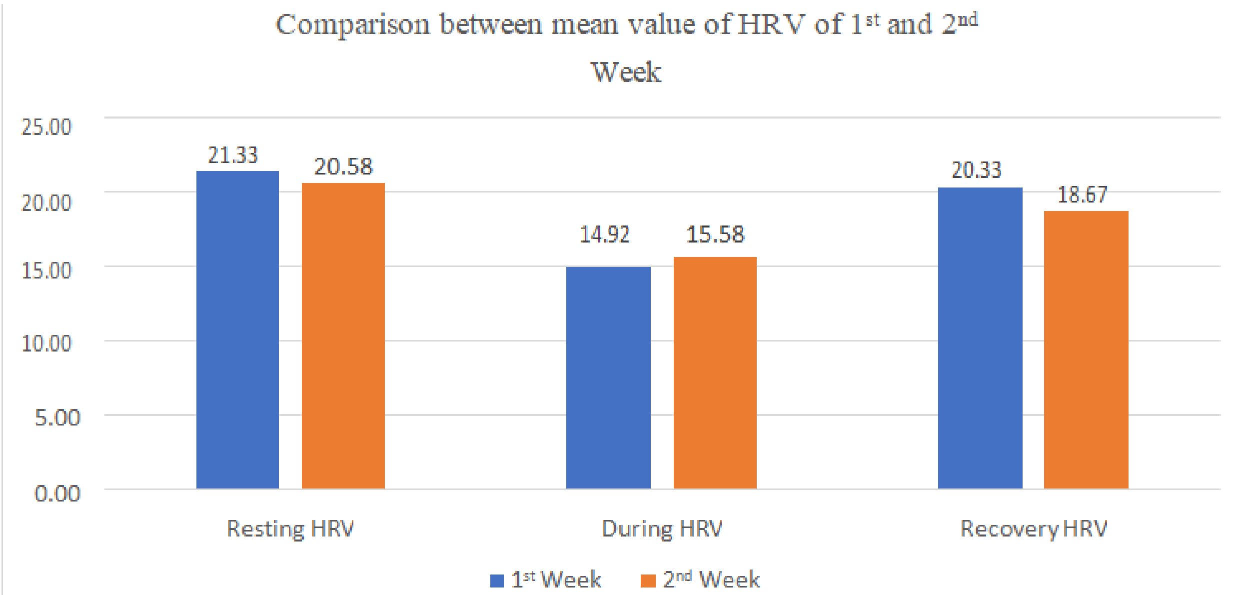

Figure 1 Graphical Representation of mean value of HRV of 1st and 2nd week

The graphical representation of HRV shows there are negligible changes found in Resting HRV, During Training HRV, and Recovery HRV (Figure 1).

Table 3 Mean value of R-R interval on 1st week and 2nd week

	RRmin resting	RRmax resting	RRavg resting	RRmin During	RRmax During	RRavg During	RRmin Recovery	RRmax Recovery	RRavg Recovery
1st week	312.33	1525.08	577.17	163.58	2301.58	476.42	167	1955.25	611.08
2nd Week	258.83	1490.25	578.42	189.75	2040.92	505	238.58	1685.5	580.42

The result shows the mean value of Resting R-R Interval of 1st week and 2nd-week RRmax, RRmin, and RRavg are 1525.08 seconds, 577.17 seconds, 312.33 seconds, and 1490.25 seconds, 578.42 seconds 258.83 seconds were found respectively. Similarly, the mean value of RRmax, RRmin, and RRavg during training of 1st week are 2301.58 seconds, 476.42 seconds, and 163.83 seconds respectively. Similarly, in 2nd week RRmax, RRmin, and RRavg during training were 2040.92 seconds, 505.00 seconds, and 189.75 seconds. Whereas, in the recovery phase the of 1st week and 2nd week the mean value of RRmax, RRmin, and RRavg are 1995.25 seconds, 611.08 seconds, 167.00 seconds, and 1685.50 seconds, 580.42 seconds, and 238.58 seconds respectively. Table 2 shows the mean value of R-R interval timing of treated and untreated weeks milliseconds respectively. Table 3 shows the mean value of HRV of treated and untreated weeks.

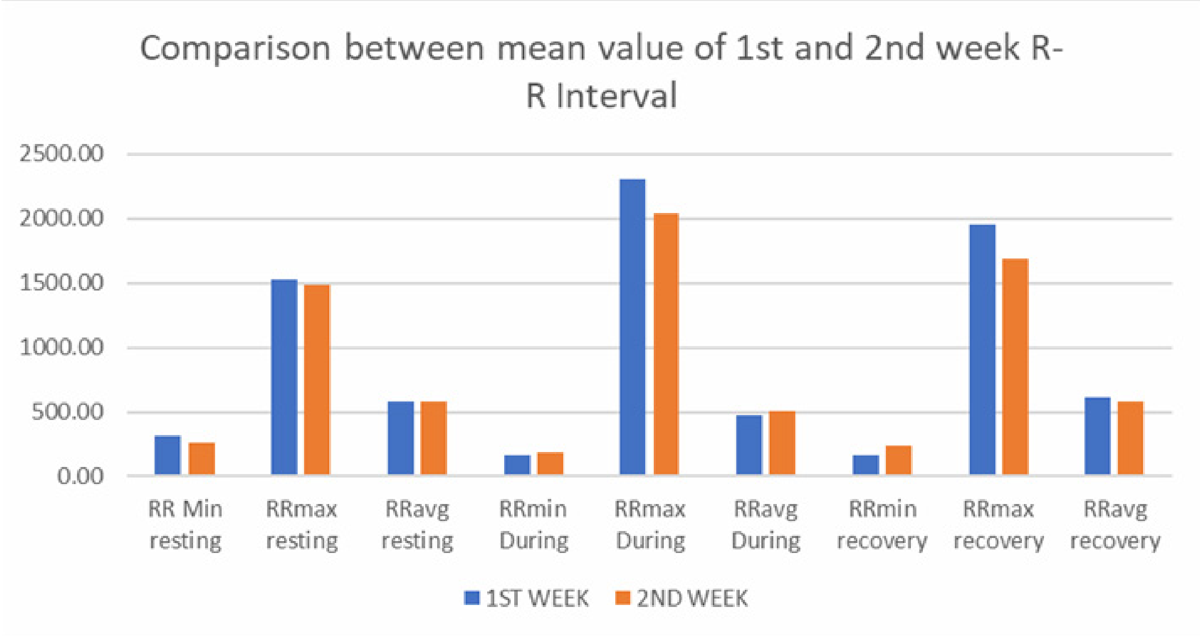

Figure 2 Comparison between the mean value of 1st and 2nd week of R-R Interval Graphical representation of R-R

Table 4 Day-wise mean value of HRV and R-R intervals

Parameters	**1st week**			**2nd week**		
	D1	**D2**	**D3**	**D4**	**D5**	**D6**
Resting HRV	26	16.25	21.75	23.25	18.5	20
RR Min resting	334.5	306.25	296.25	189.5	353.25	233.75
RRmax resting	1388	1694.75	1492.5	2044.25	1313	1113.5
RRavg resting	598	531.25	602.25	574	588	573.25
During HRV	18	14	12.75	17	13.25	16.5
RRmin During	114.75	125.5	251.25	125.75	255	188.5
RRmax During	2711.25	2350.75	1842.75	1960.5	1933.5	2228.75
RRavg During	508	474.5	446.75	512.5	494	508.5
Recovery HRV	17.75	18.25	25	22	15	19
RRmin recovery	127	66.5	307.5	175.75	382.5	157.5
RRmax recovery	2583.75	1780.5	1501.5	1726.75	1492.25	1837.5
RRavg recovery	625.25	596.25	611.75	605	558.75	577.5

From the above result, it is found that there are no significant changes in HRV and R-R interval between treated and non-treated weeks. Researchs hows that omega-3 fatty acids can inhibit the fast, voltage-dependent sodium current and the L-type calcium currents in cultured myocardiocytes. Omega-3 fatty acid inhibits prolonged refractory periods of voltage-gated Na+ channels. As a result, the shifting of steady-state inactivation to hyperpolarization occurs [7]. This decreased the Na^+ channel availability. Omega-3 also has an action on L-type calcium Ca^+ channels and it lowers cytosolic free Ca^+ and influx rate also (Table 4).

But the result shows a slight decrease in HRV and R-R intervals 2nd week than 1st week. More specifically the graph showing the RRmax During training and recovery has a slight decrease. Similarly, Figure 2 shows that HRV has a slight decrease in phase resting and recovery in comparison to 1st week which is non-treated. During resting conditions, the parasympathetic response is generally more for the engagement of the vagus nerve. But this finding suggests that Omega-3 affects sympathetic response over parasympathetic response effect. Thus, disengagement of vagus nerve activity occurs at rest. As a result, it lowers the HRV. In other studies, it is concluded that vagal activity decreases after resistance exercise in young healthy men and women. But in this study, there is no significant effect of omega-3 was found because of the short period of the study. According to research longer period intake of Flaxseed longer period for metabolism and shows a graded effect on the body. So, after taking flaxseed for a longer period it will be beneficial for individuals. Due to the lack of period for this study, it doesn't show any significant changes in heart rate as well as HRV.

CONCLUSION

Research shows flaxseed intake for longer periods help to reduce HRV and R-R interval. So, flaxseed intake is beneficial for a longer period of study. But from this study, it can be easily concluded that there is flaxseed taking not helpful in recovery for a shorter period. Also, further study is required.

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