JOURNAL OF ATHLETIC PERFORMANCE AND SPORTS MEDICINE
https://journalapsm.com
e-ISSN 3062-4517 2025, 2 (1), 36-42 *Original Article*

The Effect of 6-Week in-Season NASM-OPT Model Applications on Reactive Strength in Professional Level Female Volleyball Players

Burak Soysal[1ABCDE], Türker Bıyıklı[2CDE]

[1]*Marmara University, Institute of Health Sciences, Movement and Exercise Sciences, Istanbul, Turkey*
[2]*Marmara University, Faculty of Sports Sciences, Coaching Education Department, Istanbul, Turkey*

***Authors' Contribution:** A: Study design, B: Data collection, C: Data analysis, D: Manuscript preparation, E: Discussion and conclusion*
Corresponding author: B. Soysal
Published: 31.08.2025

DOI: 10.5281/zenodo.17014342

ABSTRACT

The aim of this study is to investigate the effects of NASM-OPT model applications implemented over a period of six weeks during the season on the Reactive Strength Index in professional female volleyball players.
In this study, a group of 15 training participants (age: 24 ± 4.6), 15 control group (age: 24.5 ± 4.5), a total of 30 female volleyball athletes participated voluntarily. The athletes performed 6-week NASM-OPT model training programs planned for the in-season period. Reactive Strength Index (RSI) tests of the athletes were measured with ENODE brand Vmaxpro (Blaumann & Meyer-Sports Technology UG, Magdeburg, Germany) sensor.
The normality of the data was assessed using the Shapiro-Wilk test, and Skewness and Kurtosis were evaluated using symmetric distributions. Categorical variables were reported as percentages and numbers, while continuous variables were reported as means and standard deviations. The independent samples t-test (Student's t-test) was employed to analyse the comparisons between RSI measurements in the training and control groups. All statistical analyses were performed using SPSS (v30.0, Statistical Package for the Social Sciences, Armonk, NY) and JAMOVI (v2.5.2) software packages. The statistical significance was set at the two-tailed $p < 0.05$ level.
The six-week distribution of RSI averages in the training and control groups was evaluated. Accordingly, in the training group, a steady increase in the mean RSI was observed from week 1 to week 6 (week 1: 1.82 ± 0.40; week 6: 2.32 ± 0.39). In contrast, RSI values remained relatively constant in the control group (week 1: 1.75 ± 0.25; week 6: 1.96 ± 0.27).
It was determined that 6-week NASM-OPT model practices applied in-season contributed to the development of reactive strength index values of professional level volleyball players compared to traditional training methods.
Keywords: Volleyball, Reactive Strength Index, Ground Contact Time, Jump Height

INTRODUCTION

In volleyball, a player's maximum height above the net is an important determinant for successful offense and block and thus for performance (García-de-Alcaraz et al., 2020). The most common types of jumps in volleyball, i.e. for attack and block, can be classified as countermovement jumps. The attack jump, performed with an approach step, can be considered a combination of drop jump (DJ) and countermovement jumps. Countermovement jumps and drop jumps are stretch-shortening cycle (SSC) movements that involve a high-intensity eccentric contraction immediately preceded by a rapid concentric contraction (Van Hooren and Zolotarjova, 2017).

The stretch-shortening cycle (SSC) is defined as a rapid stretch of a pre-activated muscle immediately preceded by a shortening of the same muscle (Goranovic et al., 2022). Depending on the duration of the SSC in the execution of the movement, exercises are divided into slow-cycle exercises (≥250 ms) and fast-cycle exercises (≤250 ms) (Turner & Jeffreys, 2010).

Since activities such as jumping are largely dependent on the ability to develop maximal force in a minimal amount of time, the reactive strength index (RSI) is a measure of the force produced and the time to develop that force and assesses vertical reactive strength (Flanagan et al., 2008). RSI is included in the literature as a reliable scientific method as a diagnostic test of functional competence to evaluate the training quality of athletes (Kayhan et al., 2021). In sports with increased jump-related loads (e.g., volleyball athletes), RSI differentiates between elite and sub-elite competitive athletes (Barnes et al., 2007).

RSI is a metric used to assess an athlete's ability to generate force rapidly and is traditionally measured during actions that demonstrate rapid stretch-shortening cycles and high jumping ability. An example is the drop jump, which aims to minimize ground contact time (GTC). The drop jump is an exercise used to assess athletes' ability to effectively execute the stretch-shortening cycle. This ability is typically reflected in a metric called the reactive strength index, which is calculated as jump height divided by ground contact time. The optimal fall height when performing DJ is not precise, especially in relation to DJ intensity (Ramírez-Campillo et al., 2013).

Reactive strength is a fundamental motoric trait for the efficient and effective execution of technical movements in volleyball. During a block, it is necessary to generate maximum force in the short time after the feet touch the ground. Similarly, when blocking, it is necessary to make the decision to jump within seconds against the opponent's offense. Such situations require reactive force to work simultaneously with the athlete's mental reflex.

As a result of the literature review and the researches we have obtained, it has been observed that topics such as reactive strength and change of direction speed, plyometric training and reactive strength relationship, reactive strength index and modified reactive strength index and attack jump relationship have been addressed for professional level volleyball athletes, but no study has been found to monitor reactive force according to the strength training model applied for 6 weeks in professional level female volleyball players. The aim of this study was to investigate the effects of NASM-OPT model applications applied for 6 weeks during the season on Reactive Strength Index in professional level female volleyball players.

METHOD

Research Group

A total of 30 female volleyball players, 15 in the training group (age: 24 ± 4.6) and 15 in the control group (age: 24.5 ± 4.5), playing volleyball at professional level in the Turkish Volleyball Federation KFC Women's 1st League, participated voluntarily in this study.

Study Design

The measurements of the athletes were taken at the beginning of each week after the rest day and this process continued with the same order for 6 weeks.

The number of weekly training days of the athletes included in the study was 6, the number of unit training days was 8-10 (double training days were 2 days), and the duration of the training sessions was 105 minutes on average per day. The athletes performed the resistance training planned for them every week for 6 weeks. While the control group followed traditional training methods, the training group performed muscle development, maximum strength, power, and maximum power training within the NASM-OPT model according to the planned period.

Body weight

Tanita HD 366 scale, which is calibrated in kilograms, has a maximum weight capacity of 200 kg and a measurement accuracy of 0.1 kg, was used to assess body composition. The athletes were asked to step on the scales barefoot and remain motionless on the scales until their weight stabilized.

Height Length

During the height measurement of athletes, they were asked to stand barefoot with their feet parallel and 60 degrees apart, with their backs to the wall and their heels, hips, back, shoulders and head touching the wall. The measurement was taken using a stadiometer (height measurer) with a sensitivity of ±0.1 cm while the head was in the Frankfurt plane. The Mesilife PT-810A device was used for height measurement.

Body Mass Index (BMI)

BMI was calculated using body weight and height values. [BMI (Body Weight (kg) / Height ($m^{2)}$].

Drop Jump Test

In this study, the Drop Jump (DJ) test was performed to evaluate the reactive strength index of the participants. In the test protocol, a standard 30 cm high box was used.

At the coach's command, the participants stepped forward and fell freely to the ground and immediately after contact with the ground, they jumped to the maximum height without delay. Participants were allowed to use their hands freely during the test. A square area with a side length of 50 cm was drawn in front of the jump box and the athletes were allowed to fall on the same area. During the measurements, the jump height (cm), ground contact time (ms) and Reactive Strength Index (RSI) data were recorded using an Enode Vmaxpro (Blaumann & Meyer-Sports Technology UG, Magdeburg, Germany) motion analyzer with a measurement frequency of 1000 Hz. Reactive Strength Index was calculated with the following formula:

RSI = Jump Height (cm) / Ground Contact Time (ms)

Figure 1. Drop Jump Test

Statistical Analysis of Data

For the data, conformity to normal distribution was assessed by Shapiro Wilk test and Skewness and Kurtosis symmetric distributions. Categorical variables were reported as percentage (%) and number (n) and continuous variables were reported as mean and standard deviation (SD). Comparisons between RSI measurements in the training and control groups were analyzed by independent samples t-test (Student's t-test). Statistical analyses of all data were performed using SPSS (v30.0, Statistical Package for the Social Sciences, Armonk, NY) and JAMOVI (v2.5.2) software packages. Statistical significance is quantified at the two-tailed $p < 0.05$ level.

FINDINGS

Descriptive statistics of the age, height, body weight and BMI values of the participants in the training and control groups are presented in tables.

Table1 . Training Group Descriptive Statistics

	Participants	Minimum	Maximum	Average	Standard Deviation
Age	15	19,00	33,00	24,07	4,65
Height Length (cm)	15	162,00	194,00	182	8,78
Body Weight(kg)	15	50,00	80,00	68,73	7,60
BMI	15	16,00	25,00	20,73	2,43

The six-week distribution of RSI averages in the training and control groups was evaluated and summarized in Table 2. The distribution of the mean RSI of the groups according to the weeks is shown in Figure 2. Accordingly, a steady increase was observed in the mean RSI of the training group from week 1 to week 6 (week 1: 1.84 ± 0.38; week 6: 2.32 ± 0.39). In contrast, RSI values remained relatively constant in the control group (week 1: 1.75 ± 0.25; week 6: 1.93 ± 0.25). There was no statistically significant difference between the training and control groups in the first three weeks ($p > 0.05$). After the 4th week, the difference between the groups was found to be significant ($p < 0.001$).

Table2. Distribution of 6-week RSI averages in training and control groups

	RSI (mean ± SD)					
Group (n = 15)	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Training	1.84 ± 0.38	1.89 ± 0.31	1.93 ± 0.35	2.10 ± 0.32	2.20 ± 0.32	2.32 ± 0.39
Control	1.75 ± 0.25	1.85 ± 0.30	1.82 ± 0.25	1.86 ± 0.21	1.91 ± 0.21	1.93± 0.25
P* value	0.204	0.526	0.101	**<0.001**	**<0.001**	**<0.001**

SD: standard deviation, * independent samples t test

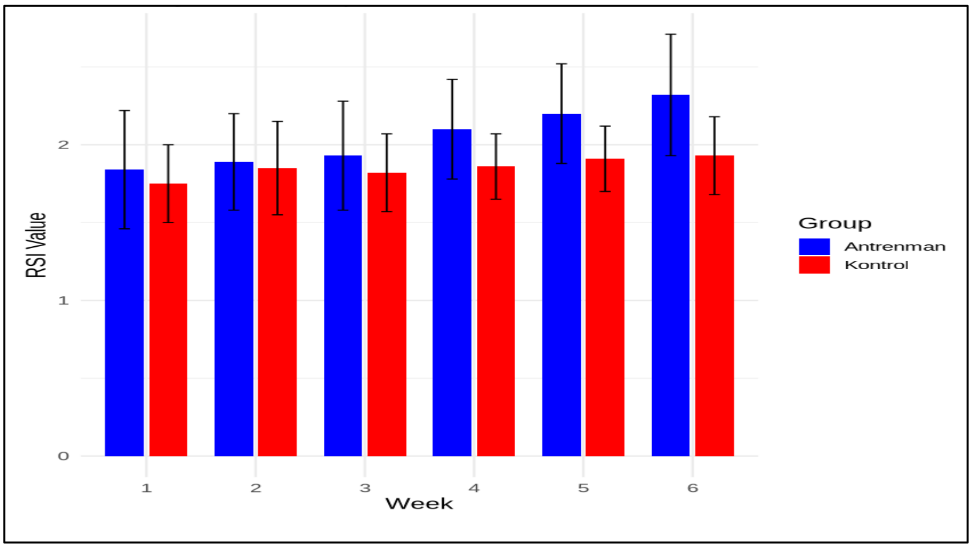

Figure 2. Distribution of 6-week RSI averages in training and control groups

Table 3 shows the distribution of the mean jump height (JH) values measured during the 6-week period in the training and control groups. The distribution of the mean JH values of the groups according to the weeks is shown in Figure 3. Accordingly, a statistically significant difference was observed between the groups at week 6 ($p = 0.004$), but no significant difference was found in the other weeks ($p > 0.05$).

Table3. Distribution of 6-week JH averages in training and control groups

	JH (mean ± SD)					
Group (n = 15)	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Training	36.79 ± 4.90	36.46± 3.81	35.78± 5.22	36.35 ± 4.04	36.94± 4.14	38.25± 4.25
Control	36.12± 5.07	36.60± 4.38	35.47 ± 4.35	35.39± 4.52	36.49± 3.96	35.66± 3.97
P* value	0.526	0.868	0.761	0.292	0.597	**0.004**

SD: standard deviation, * independent samples t test

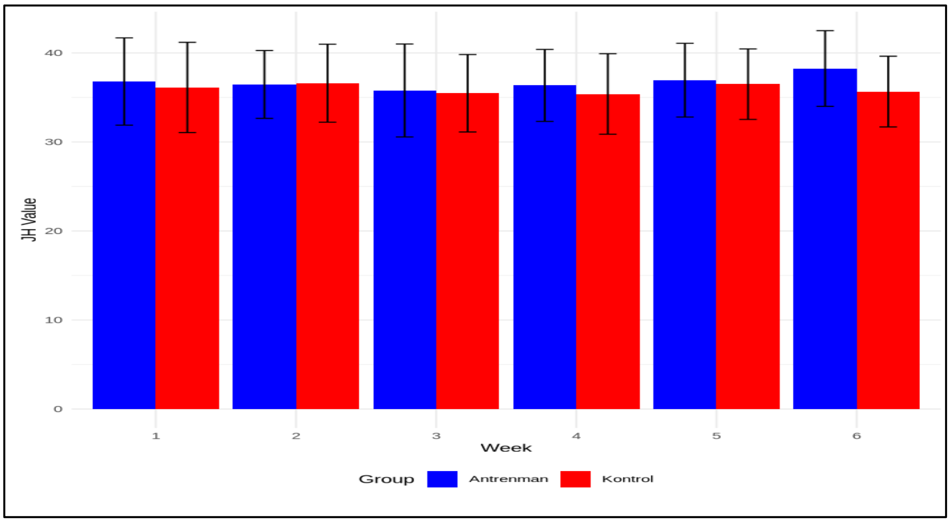

Figure 3. Distribution of JH averages in 6-week period in training and control groups

Table 4 shows the ground contact time (GTC) averages measured in the training and control groups during the 6-week period. The distribution of the GCT averages of the groups according to the weeks is shown in Figure 4. According to the independent samples t test results, statistically significant differences were found between the groups in the fifth (p <0.001) and sixth weeks (p <0.001).

Table4 . Distribution of 6-week GCT averages in training and control groups

	GCT (mean ± SD)					
Group (n = 15)	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Training	206.3± 37	194.7± 27.2	187± 22.5	174.6± 21.7	168.6± 20.9	166.8± 23.6
Control	208.3±34.2	200.5± 34	196.1± 28.7	182.5± 40.1	191 ± 23.7	185.7± 27.5
P* value	0.784	0.371	0.096	0.250	**<0.001**	**<0.001**

SD: standard deviation, * independent samples t test

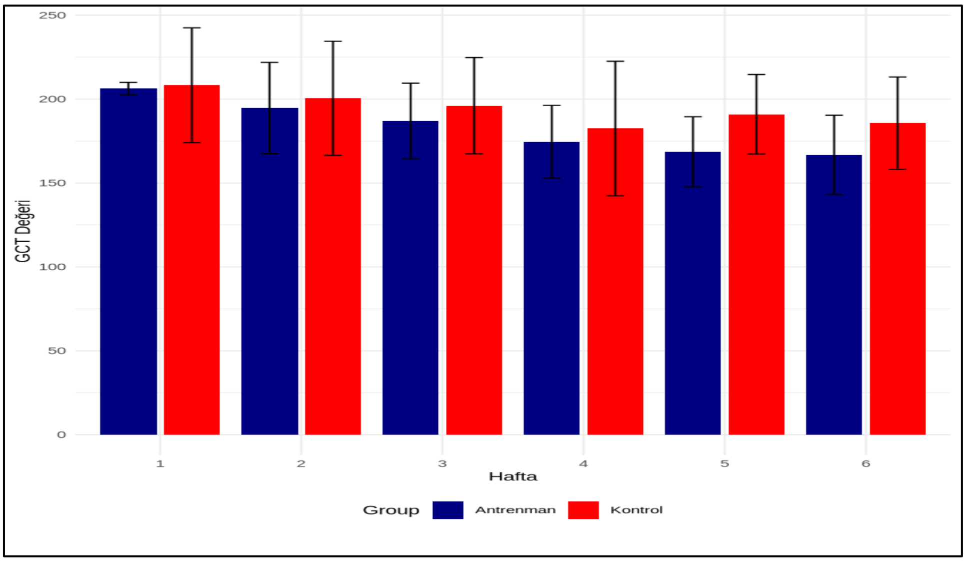

Figure 4. Distribution of GCT averages in 6-week period in training and control groups

DISCUSSION AND CONCLUSION

The main aim of this study was to evaluate the effects of an in-season 6-week training program based on the NASM-OPT model on reactive strength in professional level female volleyball players. The findings show that there were significant improvements in performance determinants such as reactive strength index (RSI) and jump height, especially in the training group. Significant decreases were also found in a sub-parameter of reactive strength such as ground contact time. These results suggest that the NASM-OPT model creates positive stimuli on the neuromuscular system, and this is reflected in performance.

Statistically significant increases (p<0.001) in RSI values, especially from the 4th week onwards, indicate that the muscle-tendon relationship works more efficiently and elastic energy utilization increases. This suggests that the athlete's reactive strength production capacity and stretch-shortening cycle efficiency increased. Flanagan and Comyns (2008) stated that controlled and systematic plyometric exercises strengthen the muscle-tendon relationship and are decisive in reactive strength development. In this context, the results of our study are consistent with the existing literature. In addition, it is thought that the increase in RSI (Table 3) and GCT (Table 5) values in the control group is due to the improvement in the athletes' test application skills.

Dong et al. (2024) found that ground reaction force and the capacity for the stretch-shortening cycle are very important in influencing jump height, while the capacity for the stretch-shortening cycle and explosiveness significantly impact ground contact time. Additionally, they observed that as the fall height increased to 30 cm, the importance of the stretch-shortening cycle capacity on jumping performance gradually increased. The results of our study show that the positive decrease in ground contact time is consistent with the literature.

Similarly, the significant increases observed in jump height indicate improvements not only in lower extremity muscle strength but also in motor coordination and power production timing. Markovic and Mikulic (2010) state that plyometric exercises have beneficial effects on muscle strength and neuromuscular performance. This improvement in jump height is a direct determinant of performance, particularly in jump-based sports such as volleyball. In game-related movements such as spikes, blocks, and serves, the athlete's time and height above the net are the main factors affecting success. Therefore, the findings obtained are directly relevant not only to test performance but also to in-game success.

Southey et al. (2024) The higher the relative strength of the athlete population, the higher the RSI value. An athlete's relative strength represents their ability to generate eccentric force sufficient to control their body weight when in contact with the ground. This enables more efficient force production and, consequently, higher jump heights. The maximal strength and power (complex method) training included in the NASM-OPT model we applied in our study had a positive effect on the results of our study. In this context, the results of our study are consistent with the existing literature.

Decreases in ground contact time indicate the development of higher motor skills such as rapid force production and agility. Shorter contact times, especially in situations such as changing direction during defense, landing on the ground after a block and jumping again, contribute positively to the tempo of the game by shortening the reaction time of the athletes. This development is a result of adaptations of the neuromuscular system towards agility. Flanagan and Comyns (2008) state that short contact time, an indicator of reactive strength, has a critical impact on sport performance.

This study joins the limited number of applied studies based on the NASM-OPT model in the literature and takes an important step towards overcoming the lack of original studies on professional female volleyball players in Turkey. In the literature, there are mostly studies conducted on male athletes or evaluating the NASM-OPT model only in off-season periods, but this study differs in that it is based on the in-season period (Markovic & Mikulic, 2010) and offers original contributions on reactive strength development in female volleyball players.

This study revealed that a 6-week NASM-OPT model-based training program applied during the in-season period increased the reactive strength index, improved jump height and decreased ground contact time in professional level female volleyball players compared to traditional resistance training. These results suggest that the NASM-OPT model can provide significant improvements in motoric performance compared to traditional training methods and is an effective method that can be safely used by coaches in in-season planning. It is recommended to be evaluated as a part of both performance and injury prevention strategies, especially in elite level female athletes.

RECOMMENDATIONS

In future studies, it is recommended to conduct comparative studies with larger sample groups, in different periods and genders. Furthermore, multidimensional analyses including physiological and biomechanical variables may reveal the effects of the NASM-OPT model more comprehensively.

REFERENCES

Barnes, J. L., Schilling, B. K., Falvo, M. J., Weiss, L. W., Creasy, A. K., & Fry, A. C. (2007). Relationship of jumping and agility performance in female volleyball athletes. The Journal of Strength & Conditioning Research, 21(4), 1192-1196.

Dong, M., Kim, Y., Xu, Y., Zhu, B., Li, M., & Kim, S. (2024). Correlations Between Jump Height, Ground Contact Time, and Athletic Performance Indicators in Jump Landing Tasks. *Annals of Applied Sport Science*, *12*(4), 0-0.

Flanagan, E. P., & Comyns, T. M. (2008). The use of contact time and the reactive strength index to optimize fast stretch-shortening cycle training. *Strength & Conditioning Journal*, *30*(5), 32-38.

Flanagan, E. P., & Comyns, T. M. (2008). The use of contact time and the reactive strength index to optimize fast stretch-shortening cycle training. *Strength & Conditioning Journal*, *30*(5), 32-38.

García-de-Alcaraz, A., Ramírez-Campillo, R., Rivera-Rodríguez, M., & Romero-Moraleda, B. (2020). Analysis of jump load during a volleyball season in terms of player role. *Journal of science and medicine in sport*, *23*(10), 973-978. https://doi.org/10.1016/j.jsams.2020.03.002

Goranovic, K., Petkovic, J., Hadzic, R., & Joksimovic, M. (2022). Rate of force development and stretch-shortening cycle in different jumps in the elite volleyball players. *Int. j. morphol*, *40*(2), 334-8.

Kayhan, R. F., Çıkıkçı, A., & Gülez, O. (2021). The effect of reactive strength index on some parameters in young soccer players. *International Journal of Sport, Exercise & Training Science*, *7*(1), 31-39.

Markovic, G., & Mikulic, P. (2010). Neuro-musculoskeletal and performance adaptations to lower-extremity plyometric training. *Sports medicine*, *40*, 859-895. https://doi.org/10.2165/11318370-000000000-00000

Ramírez-Campillo, R., Andrade, D. C., & Izquierdo, M. (2013). Effects of plyometric training volume and training surface on explosive strength. *The Journal of Strength & Conditioning Research*, *27*(10), 2714-2722.

Southey, B., Willshire, M., Connick, M. J., Austin, D., Spits, D., & Beckman, E. (2024). Reactive strength index as a key performance indicator in different athlete populations–a systematic review. *Science & Sports*, *39*(2), 129-143.

Turner, A. N., & Jeffreys, I. (2010). The stretch-shortening cycle: Proposed mechanisms and methods for enhancement. *Strength & Conditioning Journal*, *32*(4), 87-99.

Van Hooren, B., & Zolotarjova, J. (2017). The difference between countermovement and squat jump performances: a review of underlying mechanisms with practical applications. *The Journal of Strength & Conditioning Research*, *31*(7), 2011-2020.