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Evaluation of the Effect of Functional Training on Recovery Ability in Adolescent Futsal Players

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ABSTRACT

Aim: This study aimed to investigate the effects of functional training programs on the recovery levels of adolescent futsal players. Materials and Methods: The sample of the study consisted of 24 male athletes between the ages of 11-14 who were in a futsal team of a secondary school in the Beykoz district of Istanbul. In the study, the experimental method with a pre-test-post-test control group, which is one of the quantitative research methods, was used. In addition to futsal studies, the experimental group (n=12) participated in functional training 3 days a week for 2 hours for 8 weeks; while the control group (n=12) continued their classical futsal training. In the study, the Heart Rate Recovery Test (HRR) and Delayed Onset Muscle Soreness test (GKA) were used to determine the recovery levels of the players. Anthropometric measurements such as body weight, height and leg length of the participants were also made. For data showing normal distribution, paired sample t-test (intragroup comparisons) and independent sample t-test (intergroup comparisons) were used, and the significance level of the study was accepted as $p<0.05$. SPSS 25.0 program was used in the analysis of the data. Results: When variables such as height, body weight and leg length of the experimental and control groups were examined, no significant difference was found between the groups. According to other findings, a statistically significant improvement was observed in the HRR (heart rate decrease in the 1st minute) and DOMS scores of the experimental group ($p<0.05$), while no statistically significant difference was found in the control group ($p>0.05$). Conclusion: At the end of the study, it was revealed that functional training practices positively affected the recovery levels of the athletes. Therefore, it is recommended that functional training programs be given greater emphasis in training planning. Coaches should prioritize recovery processes as much as performance, as this is critically important for long-term athlete health and sustainable success.
Keywords: Agility, Physical Performance, Futsal Training, Speed

INTRODUCTION

Futsal is an indoor team sport characterized by frequent changes in tempo, requiring players to demonstrate high levels of speed, agility, decision-making, and endurance. Due to these demands, players' heart rate, lactate concentration, and neuromuscular load are elevated during futsal matches (Castagna et al., 2009). Consequently, in sports that involve high-intensity, short-duration, and repeated efforts, players' recovery capacity plays a critical role in sustaining performance and reducing the risk of injury. The literature emphasizes that training programs for futsal players should not only focus on improving physical skills but also support recovery processes (Castagna et al., 2009).

Adolescence represents a critical developmental stage in which rapid psychological, physiological, and social changes occur as individuals transition from childhood to adulthood (Betül Uncu et al., 2023). Engagement in futsal during adolescence has multifaceted developmental effects on young athletes (Lloyd et al., 2012). Regular participation in futsal training during this period has been shown to produce significant improvements in physical capacities such as cardiorespiratory endurance, anaerobic power, reactive strength, and agility (Slater et al., 2017). Positive outcomes have also been observed in cognitive functions (decision-making speed, spatial awareness, attentional control) and psychosocial development (teamwork, leadership, self-regulation) (Vestberg et al., 2017). Coaches and sport scientists are therefore advised to design age-appropriate training programs that consider the physiological loading principles of adolescent athletes and systematically implement functional training protocols (e.g., proprioceptive exercises, plyometric training, dynamic balance exercises) to maximize neuromuscular adaptation (Myer et al., 2017). Coaches play a critical role not only in enhancing immediate performance parameters but also in supporting long-term athletic development and ensuring the sustainability of athletes' careers (Myer et al., 2017).

Functional training is an approach that incorporates multi-joint and multi-planar exercises designed to enhance performance while preventing injuries by improving movement patterns similar to those used in daily life (Boyle, 2020). Particularly for adolescent athletes, such training supports developmental characteristics and holds the potential to improve both performance and recovery processes (Faigenbaum & Myer, 2022). The literature indicates that functional training enhances intermuscular coordination, allowing the neuromuscular system to operate more efficiently. This, in turn, facilitates faster alleviation of post-exercise fatigue, reduces the severity of delayed-onset muscle soreness (DOMS), and accelerates the return of recovery markers such as heart rate to baseline levels (Kellmann & Beckmann, 2018). Recovery is defined as the process by which the organism returns to baseline following physical exertion, encompassing the alleviation of physiological and psychological fatigue and the replenishment of energy stores. Effective recovery is essential for preparing athletes optimally for subsequent training sessions or competitions (Bompa & Haff, 2009). Considering that futsal is characterized by frequent high-intensity efforts, quick directional changes, and demands on anaerobic capacity, functional training can accelerate recovery post-exercise and better prepare athletes for the next performance cycle (Silva et al., 2021). Indeed, studies have reported that functional training programs not only contribute to performance enhancement in adolescent athletes but also expedite post-training and post-match recovery, making them effective tools in managing fatigue (Castagna & Castellini, 2013). Moreover, functional training is recognized as improving on-court endurance and recovery capacity in adolescent futsal players, thereby positively influencing long-term athletic development (Castagna & Castellini, 2013). Physiologically, functional training also promotes balanced muscle activation, which reduces lactic acid accumulation following exercise (Bompa & Haff, 2009).

The literature on improving recovery capacity in futsal players remains relatively limited. Existing studies primarily examine the effects of fast-paced sports such as futsal on physical performance, focusing on specific abilities including speed, balance, agility, and recovery times. For example, some studies highlight the importance of futsal players regularly engaging in agility training to enable faster and more effective movement on the court, while also supporting improved recovery times (Lloyd & Oliver, 2012). Within this context, the present study aims to provide insights into the effects of functional training on recovery capacity in adolescent futsal players.

METHOD

Research Group

This study employed a quasi-experimental design, one of the quantitative research methods. The population consisted of licensed male futsal players aged 11–14 who had been actively playing for at least two years at the middle school level. The sample comprised 24 volunteer male athletes aged 11–14 who had been licensed futsal players for a minimum of two years and were members of the star futsal team of a public middle school in the Beykoz district of Istanbul. In the study, the dependent variables were Heart Rate Recovery (HRR), Delayed Onset Muscle Soreness (DOMS), and the Post-Training Satisfaction Questionnaire, while the independent variable was the functional training program administered to the athletes. The effects of the functional training program on these variables were examined. Written parental consent was obtained, and ethical approval was secured prior to the study. The research protocol was approved by the Clinical Research Ethics Committee of Marmara University Faculty of Medicine (Protocol Code: 09.2024.136) on February 14, 2024.

Data Collection

The data collection process was conducted in the futsal hall of a public middle school in the Beykoz district of Istanbul, where participants underwent the designated tests. Athletes and their parents were provided with detailed information about the study, the tests, and the training program. Signed informed consent was obtained from both athletes and parents. The health conditions of the participants were considered throughout the study. No fees were requested from participants for their involvement in the research.

Data Collection Instruments Test Protocols

Heart Rate Recovery (HRR) Test

The HRR test was administered to assess post-exercise recovery capacity of heart rate. At the end of the functional training exercises, participants were monitored using a heart rate monitor. The HRR value was calculated by subtracting the heart rate recorded at the 1st minute of recovery from the maximum heart rate. Higher HRR values indicated faster recovery ability (Mittal et al., 2023).

Delayed Onset Muscle Soreness (DOMS) Assessment

DOMS levels were measured to evaluate muscle soreness. Participants rated their lower limb muscle soreness on a Visual Analog Scale (VAS) before training and 24–48 hours post-training. The VAS ranged from 0 (no pain) to 10 (unbearable pain). Thus, the effects of the training program on muscle soreness were evaluated (Hotfiel et al., 2024).

Functional Training Program

The functional training program was designed to improve recovery levels of 11–14-year-old male futsal players. Training sessions were held three times per week (Monday, Wednesday, Friday), with each session lasting 120 minutes over an 8-week period. Each session included a 15-minute warm-up, 90 minutes of main training, and a 15-minute cool-down with stretching.

The program consisted of functional exercises targeting both lower and upper extremity muscle groups, structured to directly contribute to players' sports performance.

Lower Extremity Exercises:

- Bodyweight and resistance squats
- Forward, backward, and lateral lunges
- Step-up exercises (stair climbing)
- Single-leg balance and balance board training
- Plyometric drills (e.g., box jumps for explosive power)

Upper Extremity Exercises:

- Push-ups with variations
- Overhead press and rotational movements with dumbbells or medicine balls
- Core stabilization (plank, side plank, sit-up variations)
- Resistance band push and pull exercises

Data Analysis

The statistical analyses of the data were conducted using SPSS 25.0 (Statistical Package for the Social Sciences). The pre-test and post-test values of recovery levels were compared between the experimental group (n = 12) and the control group (n = 12) consisting of male futsal players aged 11–14. Descriptive statistics were calculated for participants' age, height, body weight, leg length, training satisfaction, and recovery measures.

To test normality, skewness and kurtosis values were calculated and normality tests were performed. Paired Samples t-test was applied to compare the pre-test and post-test results of the experimental group, while Independent Samples t-test was used for comparisons in the control group. The p-values obtained from t-tests determined the statistical significance level, with $p < 0.05$ considered significant.

Results of the training satisfaction and recovery questionnaire were presented in percentages, with responses analyzed in terms of positive and negative feedback. Prior to statistical analysis, the distribution of the data was assessed. The assumption of normal distribution was verified using Kolmogorov-Smirnov and Shapiro-Wilk tests. As the results showed normal distribution ($p > 0.05$), parametric test methods were applied. The skewness and kurtosis values for HRR and DOMS remained within the ±1 range, confirming the normal distribution of the data.

FINDINGS

When the data regarding gender, futsal experience, and training frequency variables of the participants in the experimental and control groups were examined, it was observed that all participants in both groups were male (100%). In terms of futsal experience, 41.7% of the participants in the experimental group had 0–1 year of experience, 25.0% had 1–3 years, 8.3% had 3–5 years, and 25.0% had more than 5 years of experience. In the control group, 25.0% had 0–1 year, 33.3% had 3–5 years, and 41.7% had more than 3 years of futsal experience.

Regarding training frequency, 50.0% of the participants in the experimental group trained 1–2 days per week, 16.7% trained 5–6 days, and 33.3% trained 7 days. In the control group, 25.0% trained 1–2 days per week, 33.3% trained 3–4 days, 33.3% trained 5–6 days, and 8.3% trained 7 days per week.

Table 1. Anthropometric Measurement Values of the Experimental and Control Groups Performing Functional Training

Variable	Experimental Group (n=12)				Control Group (n=12)			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Age (years)	12.83	1.11	11.00	14.00	12.25	1.14	11.00	14.00
Height (cm)	154.50	4.62	145.00	160.00	150.75	4.22	145.00	159.00
Body Weight (kg)	47.00	4.07	42.00	54.00	47.33	4.46	42.00	55.00
Leg Length (cm)	78.75	2.45	75.00	83.00	79.42	3.12	75.00	83.00

When the data on age, height, body weight, and leg length variables of the participants in the experimental and control groups were examined, the mean age was found to be 12.83 ± 1.11 years in the experimental group and 12.25 ± 1.14 years in the control group. The mean height was 154.50 ± 4.62 cm in the experimental group and 150.75 ± 4.22 cm in the control group. In terms of body weight, the mean value was 47.00 ± 4.07 kg for the experimental group and 47.33 ± 4.46 kg for the control group. Finally, the mean leg length was determined as 78.75 ± 2.45 cm in the experimental group and 79.42 ± 3.12 cm in the control group.

The pre-test and post-test measurement results of the HRR (Heart Rate Recovery) test for the experimental and control groups included in the study are presented in Table 2.

Table 2. Comparison of Pre-Test and Post-Test HRR (Heart Rate Recovery Test) Measurements of the Group Performing Futsal-Specific Functional Training and the Group Performing Futsal-Specific Traditional Training

Group	Test	Mean ($\bar{X}$)	SD	t-value	p
Experimental	Pre-Test	18.91	2.86		
	Post-Test	24.30	3.11	-4.52	0.001
Control	Pre-Test	19.07	2.70		
	Post-Test	19.84	2.98	-1.04	0.320

In the experimental group, a significant increase in HRR values was observed following the functional training protocol ($\bar{X}$±SD = Pre-test: 18.91±2.86; Post-test: 24.30±3.11). The paired samples t-test indicated that this increase was statistically significant ($t(11) = -4.52$, $p = 0.001$). This finding demonstrates that the athletes in the experimental group improved their post-exercise recovery rates. The significance level was set at $p < 0.05$.

In the control group, although a slight increase in HRR values was recorded ($\bar{X}$±SD = Pre-test: 19.07±2.70; Post-test: 19.84±2.98), no statistically significant difference was found between the pre-test and post-test measurements ($t(11) = -1.04$, $p = 0.320$; $p > 0.05$). This result suggests that the recovery capacity of the control group, which followed only the traditional training program, did not improve significantly.

In conclusion, the 8-week functional training program applied to the experimental group significantly improved the heart rate recovery values of adolescent futsal players. This finding supports the positive effects of functional training on cardiovascular recovery capacity.

The pre-test and post-test measurement results of the DOMS (Delayed Onset Muscle Soreness) test for the experimental and control groups are presented in Table 3.

Table 3. Comparison of Pre-Test and Post-Test DOMS (Delayed Onset Muscle Soreness) Measurements of the Group Performing Futsal-Specific Functional Training and the Group Performing Futsal-Specific Traditional Training

Group	Test	Mean ($\bar{X}$)	SD	t-value	p
Experimental	Pre-Test	5.48	1.12		
	Post-Test	3.18	1.03	4.23	0.001
Control	Pre-Test	5.32	1.04		
	Post-Test	5.07	1.15	0.82	0.428

Participants were asked to evaluate the level of muscle soreness in the lower extremity muscle groups at the 24th and 48th hours after training. The collected data were analyzed to determine whether there was a significant difference between pre-test and post-test results within the groups. A paired samples t-test was applied for both groups to assess whether the differences were statistically significant. The significance level was set at $p < 0.05$.

In the experimental group, a clear decrease in DOMS values was observed following the functional training program ($\bar{X}$±SD = Pre-test: 5.48±1.12; Post-test: 3.18±1.03). The paired samples t-test revealed that this decrease was statistically significant ($t(11) = 4.23$, $p = 0.001$). This indicates that the functional training program reduced muscle damage and post-exercise muscle soreness in the experimental group.

In the control group, however, no significant change in DOMS values was observed ($\bar{X}$±SD = Pre-test: 5.32±1.04; Post-test: 5.07±1.15), and the analysis confirmed that the difference was not statistically significant ($t(11) = 0.82$, $p = 0.428$).

The frequency analyses of the Training Satisfaction, Performance, and Recovery Questionnaire administered to the experimental group are presented in Table 4.

Table 4. Evaluation of Training Satisfaction, Performance, and Recovery Questionnaire Results of the Experimental Group

Question	Response	N	%
1. How beneficial did you find the functional training program?	Not beneficial at all	0	0.0
	Slightly beneficial	0	0.0
	Moderately beneficial	2	16.7
	Very beneficial	3	25.0
	Extremely beneficial	7	58.3
Total		12	100.0
2. Did you feel motivated during the training program?	Not motivated at all	0	0.0
	Slightly motivated	0	0.0
	Moderately motivated	5	41.7
	Very motivated	5	41.7
	Extremely motivated	2	16.7
Total		12	100.0
3. Did you feel any improvement in your physical performance during the training program?	No improvement	0	0.0
	Slight improvement	1	8.3
	Moderate improvement	3	25.0
	Significant improvement	3	25.0
	Very significant improvement	5	41.7
Total		12	100.0
4. How would you evaluate the program’s effects on your recovery level?	No effect	0	0.0
	Slight effect	3	25.0
	Moderate effect	3	25.0
	Strong effect	1	8.3
	Very strong effect	5	41.7
Total		12	100.0
5. How did you feel after the training?	Very tired	0	0.0

Question	Response	N	%
	Tired	0	0.0
	Moderately tired	4	33.3
	Slightly tired	3	25.0
	Not tired at all	5	41.7
Total		12	100.0
6. How long did it take you to recover after the training?	1–2 hours	1	8.3
	3–4 hours	4	33.3
	5–6 hours	7	58.3
	7–8 hours	0	0.0
	1 day or more	0	0.0
Total		12	100.0
7. Which performance indicators did you notice improvements in during training?	Balance	2	16.7
	Agility	0	0.0
	Speed	5	41.7
	Reactive strength	5	41.7
	Endurance	0	0.0
Total		12	100.0
8. Did you experience any pain or injury after the training?	Yes	0	0.0
	No	12	100.0
Total		12	100.0

Upon examining the frequency analyses of the Training Satisfaction, Performance, and Recovery Questionnaire administered to the experimental group, it was found that 58.3% of the participants evaluated the functional training program as “extremely beneficial,” while only 16.7% considered it “moderately beneficial.”

Regarding motivation during the training sessions, 41.7% of the participants reported being “moderately motivated,” and another 41.7% indicated being “highly motivated.” Similarly, 41.7% of the participants stated that they perceived a “very significant improvement” in their physical performance, while 25.0% reported a “moderate improvement.”

With respect to recovery level, 41.7% of the participants stated that the program had an “extremely positive effect.” In terms of post-training fatigue, 41.7% of the participants reported feeling “not tired at all,” whereas 33.3% indicated they felt “moderately tired.”

For recovery duration, 58.3% of the participants reported recovering within 5–6 hours. Regarding performance indicators, 41.7% noted improvements in recovery-related parameters, while 16.7% reported perceiving overall performance improvements. Finally, none of the participants experienced pain or injury following the training, with 100% responding “no” to this item.

DISCUSSION AND CONCLUSION

This study, conducted to evaluate the effect of functional training on recovery levels in adolescent futsal players, compared the findings obtained with parameters against similar studies in the literature.

Although no significant differences were found between the experimental and control groups in terms of demographic characteristics, the applied functional training program was observed to have positive effects on recovery levels as well as on various motor skills. The findings revealed that functional training had significant positive effects on heart rate recovery (HRR) and delayed onset muscle soreness (DOMS).

In terms of recovery duration, a significant improvement was observed in the post-test results of the experimental group ($p<0.05$). This finding is consistent with the study of Dedecan (2016), which demonstrated the positive effects of core training on the physical and physiological characteristics of adolescent male students. Similarly, Boyacı (2016) emphasized the beneficial effects of core strength training on motoric characteristics. The greater improvement in recovery in the experimental group compared to the control group supports the idea that functional training programs contribute to endurance and recovery processes.

The improvement observed in the HRR test indicates enhanced cardiovascular recovery capacity among athletes. This finding is supported by Buchheit and Laursen (2013), who noted that the recovery process following high-intensity exercise is a critical indicator of athletes’ fitness levels. Thus, the results of this study are consistent with existing literature.

Similarly, the significant decrease in DOMS scores highlights the effectiveness of functional training in reducing muscle damage and post-exercise soreness. Howatson and Van Someren (2008) also reported that such training reduces muscle loading and accelerates musculoskeletal recovery. Considering that the participants in this study were adolescents, these improvements are even more meaningful in terms of motor learning and neuromuscular adaptation. Faigenbaum and Myer (2010) emphasized that multidimensional functional training in youth athletes creates lasting positive effects on developing physiological systems.

The positive role of functional training in enhancing recovery capacity has also been reported in large-scale surveys such as the Turkey Fitness Trends Survey (Kafkas, 2022). According to this survey, experts noted that functional training provides significant advantages in improving motor skills, preventing injuries, and accelerating recovery, particularly in young individuals.

By involving multi-joint, multidirectional movements, functional training can improve cardiovascular adaptation and shorten recovery time. This enhances both heart rate regulation and reduces muscle fatigue (La Scala Teixeira et al., 2016).

The Sport Psychological Recovery Scale (SPRS) developed by Kaygusuz and Karagözoğlu (2023) has been used to evaluate psychological recovery and showed that athletes felt more energetic and motivated after training. Thus, functional training contributes not only to physiological but also to psychological recovery.

In line with this, Bozkurt et al. (2021) found that functional training programs applied to young football players improved endurance, strength, and recovery, supporting the results of this study. Questionnaire-based research in the literature has also highlighted the role of training frequency and intensity on recovery, showing that three sessions per week can create a favorable balance between recovery and performance (Demirtaş & Güner, 2020). This is consistent with the eight-week, three-session-per-week protocol applied in this research.

Additionally, Karaca et al. (2021) found that, besides recovery strategies such as active rest, massage, and cold application, functional training also accelerates recovery and reduces injury risk.

In terms of recovery, the post-test results revealed a significant improvement in the experimental group, which can be attributed to the ability of functional training to enhance endurance and optimize energy use. Karahan (2012) highlighted that high-intensity interval training had positive effects on aerobic and anaerobic performance in futsal players, while Erikoğlu (2015) showed that agility and body composition are significant determinants of recovery and overall performance in footballers. The improvement in recovery in this study similarly supports the contribution of functional training to conditioning and rehabilitation processes.

Overall, the findings indicate that an eight-week functional training program implemented with 11–14-year-old adolescent futsal players had significant and positive effects on recovery levels. Specifically, HRR and DOMS values demonstrated statistically significant improvements in favor of the experimental group.

The joint evaluation of HRR and DOMS suggests that functional training provides a dual recovery effect on both the autonomic nervous system and the musculoskeletal system, as also indicated by Stanley, D'Auria, and Buchheit (2015).

The multi-joint, dynamic, sport-specific exercises included in functional training directly meet the demands of the sport. These exercises not only improve performance but also enhance post-exercise physiological recovery, allowing athletes to be better prepared for subsequent training sessions or competitions. In this regard, the study's findings align with previous research reporting the contribution of functional training to post-exercise recovery (Bozkurt et al., 2021; Kaygusuz & Karagözoğlu, 2023).

The improvements observed in HRR results further confirm the positive effects of functional training on the cardiorespiratory system, as indicated by Gastin and Bennett (2021). Faster post-exercise heart rate recovery reflects improved aerobic fitness and suggests that athletes may experience less physiological strain during high-intensity matches.

The decrease in DOMS values demonstrates that the applied exercises not only improved musculoskeletal adaptation but also reduced muscle damage, thereby accelerating recovery. This is particularly important for adolescent athletes, as inappropriate loading during growth phases can increase the risk of injuries and overtraining (Karaca et al., 2021).

Taken together, these findings show that functional training provides substantial benefits not only for performance improvement but also for the recovery processes of adolescent athletes. Therefore, it is important that coaches, physical education teachers, and sport scientists systematically integrate functional training into their programs to support both performance development and athlete health.

Furthermore, starting such recovery-supportive training methods at an early age may reduce future injury risks, extend athletic careers, and enhance long-term success (Kafkas, 2022).

Finally, the high satisfaction levels among participants, with 58.3% rating the program as "extremely beneficial," highlight the motivational and performance-enhancing effects of functional training. The low levels of post-training fatigue and acceptable recovery durations also suggest that the program was well-balanced in terms of load and rest. This is consistent with the findings of Karabulak (2013) and Boyacı (2016), who reported that appropriately dosed strength and endurance training supports performance development in athletes.

RECOMMENDATIONS

Considering that functional training programs have positive effects on balance and recovery levels in adolescent futsal players, such training should be expanded and systematically integrated into routine training processes, particularly for youth academy athletes.

Due to the emergence of individual differences in training outcomes, functional training content should be personalized according to athletes' age, physical characteristics, training background, and performance levels to make the development process more efficient.

Although positive changes were observed in the recovery times of the experimental group, it is important to include supportive practices such as active recovery, cool-down exercises, flexibility work, and breathing techniques in training programs to further accelerate recovery.

In-service training programs should be organized to enhance the knowledge and skills of coaches and physical education teachers regarding functional training methods and applications. These programs should cover topics such as functional training techniques, individualized training planning, and recovery strategies for athlete health.

While functional training applications have been shown to yield short-term positive outcomes in adolescence, longitudinal studies with different age groups, longer durations, and larger samples are needed to assess the long-term sustainability of these gains.

In addition to functional training practices, factors such as active recovery, nutrition, sleep patterns, and psychological recovery should also be taken into account, and a holistic recovery approach should be adopted.

This study covers a short-term intervention. To more clearly evaluate the effects of functional training, studies involving different age groups, longer durations, and larger participant samples are required.

Regular measurement of athletes' recovery levels at specific intervals using tests such as HRR and DOMS would allow determination of individual load-tolerance limits and help reduce the risk of overtraining.

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