The Effect of Different Exercise Methods on Shooting Performance in Archers*

Bünyamin YAMANARDA**, Deniz DEMİRCİ***

Abstract

Aim: The purpose of this research was to investigate how various exercise approaches targeting the scapular region influence the shooting performance of archers between the ages of 15 and 24.

Method: A total of 30 archer athletes participated in the study and were randomly assigned to three groups using stratified sampling. Subsequently, the exercise protocols to be applied to each group were determined as follows: Scapular Proprioceptive Neuromuscular Facilitation group (PNF, n=10), Scapular Stabilization Exercise group (SSE, n=10) and Control group (CG, n=10). Participants in each group performed their respective exercises twice a week for 8 weeks. Shooting performance was evaluated based on pre-test and post-test scores obtained from shots taken at a distance of 18 meters, following the indoor archery guidelines. For within-group analyses, the Paired Samples t-Test was used, and to assess changes in shooting performance over time and group-time interaction, Repeated Measures ANOVA was conducted.

Results: No significant differences were found among the groups in terms of sociodemographic characteristics (age, years of sport experience, height, and weight). A significant improvement in shooting performance was observed within all three groups ($p<0.001$). The SSE group showed a significantly greater improvement in performance compared to the control group ($p<0.001$). Similarly, the PNF group also demonstrated a significant improvement in shooting performance compared to the control group ($p=0.034$).

Conclusion: Both scapular proprioceptive neuromuscular facilitation (PNF) and scapular stabilization exercises may contribute to improvements in individual performance; however, no significant superiority was observed between the two methods. Future studies are recommended to explore the long-term effects of these exercises and to develop individualized training programs.

Keywords: Archery, PNF, scapular stabilization exercises, shooting performance.

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Okçularda Farklı Egzersiz Yöntemlerinin Atış Performansı Üzerine Etkisi

Öz

Amaç: Bu çalışma, 15-24 yaş arası genç okçularda skapula üzerinde uygulanan farklı egzersiz yöntemlerinin atış performansına etkisini incelemek amacıyla planlanmıştır.

Yöntem: Çalışmaya toplam 30 okçu sporcu dahil edildi ve okçular tabakalı örnekleme yöntemiyle rastgele seçilerek üç gruba ayrıldılar. Daha sonra rastgele grupların uygulayacağı egzersizler belirlendi: Skapular Proprioseptif Nöromüsküler Fasilitasyon grubu (PNF, n=10), skapular stabilizasyon egzersiz grubu (SSE, n=10) ve kontrol grubu (KG, n=10). Her gruptaki sporcular 8 hafta boyunca haftada 2 gün kendi gruplarındaki egzersizleri uyguladılar. Katılımcıların atış performansları salon okçuluğu talimatnamelerine uygulan olarak 18 metre mesafeden yapılan atışlarla, ön test ve son test skorları üzerinden değerlendirildi. Grup içi analizlerde Bağımlı Örneklem t Testi, grupların atış performansındaki zaman içindeki değişim ve grup-zaman etkileşimini değerlendirmek amacıyla Tekrarlı Ölçümler ANOVA analizi gerçekleştirildi.

Bulgular: Grupların sosyo demografik verileri (yaş, spor yılı, boy, ağırlık) karşılaştırıldığında anlamlı bir fark tespit edilmemiştir. Her üç grubun grup içi analizlerinde anlamlı bir performans artışı gözlenmiştir ($p<0,001$). SSE grubunda, kontrol grubuna kıyasla anlamlı bir performans artışı saptanmıştır ($p<0,001$). PNF grubunun atış performansında da kontrol grubuna kıyasla anlamlı bir artış gözlemlenmiştir ($p=0,034$). Buna karşın, PNF ve SSE grupları karşılaştırıldığında istatistiksel olarak anlamlı bir farklılık bulunmamıştır ($p>005$).

Sonuç: Hem skapular PNF hem de skapular stabilizasyon egzersizleri, bireysel performans gelişimine katkı sağlayabilir; ancak iki yöntem arasında belirgin bir üstünlük gözlenmemiştir. Gelecekte yapılacak çalışmalarda, bu egzersizlerin uzun vadeli etkilerinin araştırılması ve bireyselleştirilmiş antrenman programlarının geliştirilmesi önerilmektedir.

Anahtar Sözcükler: Okçuluk, PNF, skapula stabilizasyon egzersizi, atış performansı.

Introduction

Archery is one of the oldest sporting activities in human history, maintaining its presence both globally and in Türkiye, while continuing to sustain its popularity today. Moreover, it is among the sports that positively contribute to physical, psychomotor, and cognitive development in both healthy and disabled individuals[1,2]. In addition, achieving high performance and executing accurate shots at the target require parameters such as strength, balance, and the cardiovascular system to be maintained at an optimal level. Likewise, in order to demonstrate superior performance and ensure precise shooting, it is of great importance that parameters such as strength, balance, and the cardiovascular system are at an optimal level[3,4].

Archery consists of dynamic phases such as bow holding, drawing, full draw, aiming, release, and follow-through[5]. During these phases, a contraction-relaxation cycle occurs in the muscles of the back, shoulder, arm, forearm, and fingers, with active muscle groups varying at each stage of the process[4]. In sports like archery, where upper extremity muscles are heavily utilized, strengthening the shoulder and scapular muscle groups plays a critical role in increasing athletic performance[6].

Performance is a multifaceted concept shaped by the combination of physical, physiological, psychological, and technical components. Sports performance is

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influenced by a wide range of both internal and external factors[7,8]. Physical fitness is one of the key determinants of archery performance and is particularly critical for novice athletes[9]. Research has shown that archers need to possess sufficient strength and endurance in order to achieve accurate shots and maintain balance[10].

Proprioceptive Neuromuscular Facilitation (PNF) is a rehabilitation method designed to enhance muscular strength, promote relaxation and improve functional performance by facilitating neuromuscular mechanisms through specific muscular techniques[11,12]. Evidence suggests that PNF can improve the functional capacity of major muscle groups through the reciprocal activation of agonist and antagonist muscles[13]. Scapular stabilization exercises (SSE), widely utilized in both rehabilitation settings and athletic training, have been shown to not only increase muscular strength but also support proprioceptive development and contribute to the management of scapular dyskinesis[14]. Previous studies have demonstrated that SSE protocols implemented in tennis players diagnosed with scapular dyskinesis led to significant enhancements in joint mobility and muscular strength, as well as a reduction in the severity of dyskinesis[15].

While the effectiveness of scapular PNF and stabilization exercises has been explored across different patient populations and athletic groups, there appears to be a lack of studies specifically examining how these exercise approaches influence shooting performance in young archers aged 15 to 24. Therefore, this study seeks to examine the impact of PNF exercises in the scapular pattern and scapular stabilization exercises on the shooting performance of young archers within this age range.

Material and Methods

Study Group

A quantitative research method employing a pretest–posttest control group experimental design was utilized in this study. The study group consisted of archery athletes registered with the Lider Education Youth and Sports Club in Istanbul, who were actively training with recurve bows and were between the ages of 15 and 24 during the period of December 2024 to January 2025. A total of 30 archers (regardless of gender) who met the inclusion criteria—being aged 15–24, participating in regular training, having practiced archery for at least one year, having no upper extremity injuries in the past six months and voluntarily agreeing to participate—were included in the study. The power analysis determined that at least 30 participants were needed to identify a moderate effect size (f=0.30) with 80% power.

The exercise interventions were carried out at the Üsküdar University Physiotherapy and Rehabilitation Application and Research Center (ÜSFİZYOTEM).

Participant Grouping Procedure

A total of 30 archers participating in the study were assigned into three groups (Group A, Group B, Group C), with an equal number of athletes in each group (n=10), using a stratified random sampling method. This method is based on dividing the population into homogeneous subgroups (strata) according to one or more characteristics and then

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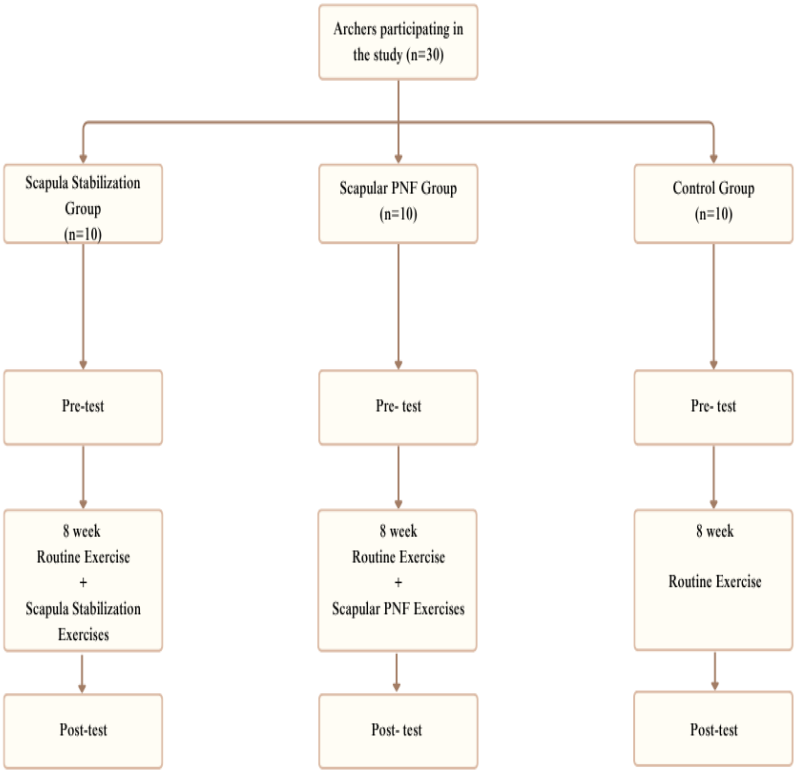
selecting samples from these strata[16]. In this study, participants were stratified based on age and an equal number of individuals from each stratum were randomly selected and evenly distributed into the three groups. This approach aimed to ensure that the groups consisted of participants with similar characteristics and to enhance the reliability of the study findings.

Following group allocation, the exercise protocols to be applied in each group were determined through random assignment. Accordingly, one group was assigned to perform scapular PNF exercises, another to SSE and the third served as the control group, continuing only their routine training program (Figure 1). The experimental groups carried out the designated exercises alongside their standard training, whereas the control group maintained only their usual training routine.

Figure 1. Flowchart of the study



Exercise Protocols

Scapular Stabilization Exercises

Scapular retraction exercise in the prone position: *While* lying prone and keeping the elbows fully extended, the individual performs the movement by retracting the scapula[17].

Push-up exercise on the wall with an exercise ball (Figure 2): The exercise began with both hands placed on a therapy ball against the wall, with the elbows in full

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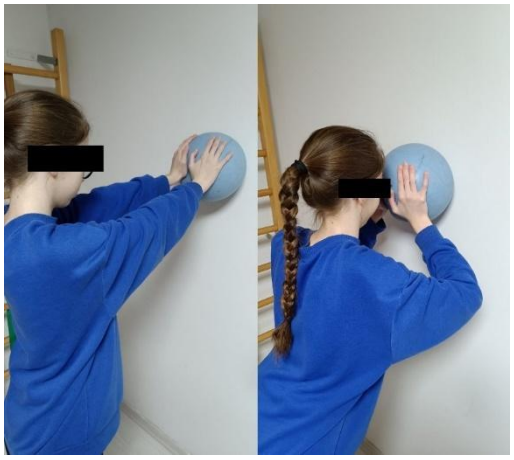
extension. Participants performed the movement by approaching the ball in a push-up–like manner and then returning to the starting position[18].

Figure 2. Push-up exercise on the wall with an exercise ball



Scapular retraction exercise with resistance band: This exercise was performed by pulling a resistance band posteriorly while the arms were positioned in 90 degrees of abduction[19].

Dynamic stabilization with exercise ball on the wall (Scapular clock exercise) (Figure 3): This exercise is used to facilitate joint kinesthesia and range of motion by promoting scapular movements such as elevation, depression, protraction and retraction. During the exercise, the participant stands facing the wall and places one arm on the exercise ball with the elbow fully extended. Visualizing a clock face, the participant moves the ball in the directions of 3, 6, 9, and 12 o'clock sequentially[20].

Figure 3. Dynamic stabilization with exercise ball on the wall

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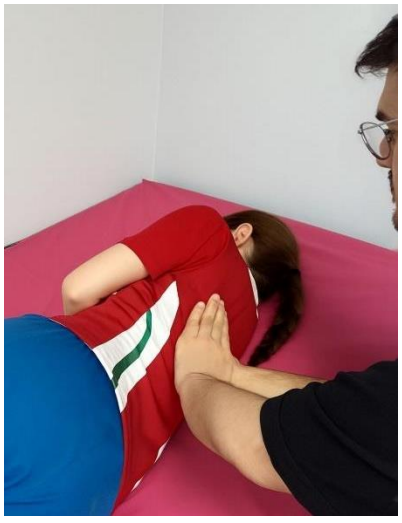
Scapular PNF Exercises

Scapular PNF exercises (Figure 4) were administered by an experienced physiotherapist based on the patterns of "anterior elevation–posterior depression" and "anterior depression–posterior elevation"[21]. During the intervention, the "repeated stretch" technique was employed to improve muscle strength and joint range of motion[22]. This technique, designed to improve scapular mobility and stabilization, aims to increase active joint movement and muscle strength through the patient's active participation. In this method, the agonist muscles are first positioned in a maximally lengthened state, followed by a brief and rapid stretch at the beginning of the movement. Subsequently, isotonic contractions are performed against resistance throughout the movement. If weakness is detected at any point during the motion, additional brief and rapid stretches may be applied[23].

Figure 4. Scapular PNF exercise (posterior depression pattern)



Control Group Exercises

Archers in the control group continued to perform their routine exercise programs determined by their coach, with no additional interventions applied during the study period. These exercises included the following:

Unilateral resistant band rowing exercise: This exercise targets the scapular region, back and shoulder muscles actively engaged during archery shooting, aiming to improve postural control, muscle strength and muscular endurance. The resistance band rowing movement specifically supports the development of motor control related to the pulling action[24].

Weighted biceps and triceps exercises: These exercises are commonly utilized to increase upper extremity muscle strength and hypertrophy. They are considered effective methods particularly for enhancing the functional capacity of the biceps brachii and triceps brachii muscles[25,26].

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Shoulder girdle strengthening exercises using weights: These exercises target the deltoid, trapezius, and rotator cuff muscles, aiming to enhance the power and functional performance of the shoulder muscles, thereby reducing the risk of injury[27].

Data Collection

Sociodemographic information form: Through this form, data regarding the athletes' gender, age, years of sports participation, height, weight, training routines and injury history were collected and recorded.

Shooting performance test: Athletes' shooting performances were evaluated based on shots taken from an 18-meter distance in accordance with the Indoor Archery Regulations of the Turkish Archery Federation (TAF) and World Archery (WA)[28]. During the assessment, participants performed a total of 10 shots, with the first 4 shots serving as warm-up and excluded from the evaluation. For shooting performance, the scores of the last 6 shots were recorded[29]. The target face used in the shooting test was a standard indoor target paper according to FITA regulations, consisting of concentric colored rings. The scoring system was as follows: the innermost yellow ring scored 10 points, the second yellow ring scored 9 points, the red rings scored 8 and 7 points respectively, the blue ring scored 6 points and the white area scored 5 points[28]. All athletes were subjected to this test before starting (pre-test) and after completing (post-test) the exercise program and their performance changes were recorded.

Ethical Statement

Ethical approval for this study was obtained from the Non-Interventional Clinical Research Ethics Committee of Üsküdar University with the decision dated 28.10.2022 and numbered 61351342/October 2022-63. Additionally, a supplementary approval was obtained on 26.05.2025 with the decision numbered 61351342/020-1167 for the revision of the thesis title during the research process. A signed subject consent form in accordance with the Declaration of Helsinki was obtained from each participant. All participating athletes and their families were informed in detail about the purpose and duration of the study, the exercise protocols to be implemented, and the assessments to be conducted. Voluntary participation was emphasized, and written informed consent was obtained from all participants and from the legal guardians of individuals under the age of 18.

Statistical Analysis

The data were analyzed with IBM SPSS Statistics software (version 30.0). Descriptive data were expressed in terms of mean, standard deviation, and percentages. The Shapiro-Wilk test was applied to assess whether the data were normally distributed and the results showed normal distribution in both experimental and control groups. Accordingly, parametric tests were used for the analyses. Between-group comparisons of pre-test and post-test results were performed using One-Way Analysis of Variance (One-Way ANOVA). Within-group comparisons were conducted using the Paired Samples t-Test. Additionally, to examine changes in shooting performance over time and the group-

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by-time interaction, Repeated Measures ANOVA was applied. When significant differences were detected between groups in the ANOVA analyses, Tukey's Honestly Significant Difference (Tukey HSD) test was used as the post hoc test to determine which groups accounted for the differences. Statistical significance was set at $p \leq 0.05$ for all analyses.

Results

The mean values of age, sports experience (years), height and body weight for the groups, along with the significance levels for these variables, are presented in Table 1.

Table 1. Comparison of Sociodemographic data among groups

	Scapular Stabilization Group Mean ± (SD)	**PNF Group Mean ± (SD)**	**Control Group Mean ± (SD)**	**F**	**p**
Age	18.2 ± (2.57)	18.4 ± (2.63)	18.1 ± (3.03)	0.031	0.970
Sports experience	3.80 ± (1.99)	4.20 ± (1.93)	3.50 ± (1.96)	0.321	0.728
Height (cm)	169 ± (7.82)	170 ± (9.29)	168 ± (8.55)	0.122	0.886
Body weight (kg)	67.3 ± (10.1)	68.9 ± (11.2)	65.8 ± (9.24)	0.221	0.804

p: One-way ANOVA (<0.05), F: F-value (variance ratio), Mean: mean value, SD: standard deviation

When comparing the mean ages of the groups, no statistically significant difference was observed ($p>0.05$). Similarly, no significant difference was found between the groups in terms of the archers' sports experience ($p>0.05$). The mean height and body weight of the archers in the groups were close to each other and no statistically significant differences were detected among the groups ($p>0.05$).

The mean scores of shooting performance pre-test and post-test, change rates and the results of the related statistical analyses for the groups are presented in Table 2.

Table 2. Shooting performance pre-test, post-test averages, change rates and statistical analysis results

	Scapular Stabilization Group Mean	**PNF Group Mean**	**Control Group Mean**	**F**	**η^2**	**p**
Pre-test Mean	46.70	45.00	44.70	1.509	0.101	0.239
Post-test Mean	55.20	52.80	47.40	35.438	0.724	**<0.001**
Change (%)	%18.20	%17.33	%6.04			

p: One-way ANOVA (<0.05), F: (F-ratio), η^2: (Effect size)

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As shown in Table 2, an increase in shooting performance test scores from pre-test to post-test was observed in all groups. The greatest improvement was seen in the group performing scapular stabilization exercises (18.20%). Analysis of the pre-test mean scores revealed no statistically significant difference in shooting performance between the groups ($p>0.05$). However, the post-test mean scores indicated a statistically significant difference in shooting performance among the groups ($p<0.05$).

The comparison of pre-test and post-test mean scores of the shooting performance test within the experimental and control groups is presented in Table 3.

Table 3. Comparison of within-group mean scores of the shooting performance test

	Pre-test Mean	**Post-test Mean**	**t**	**Cohen's d**	**p**
Scapular Stabilization Group	46.70	55.20	-27.659	-8.746	**<0.001**
PNF Group	45.00	52.80	-16.714	-5.286	**<0.001**
Control Group	44.70	47.40	-8.060	-2.549	**<0.001**

p: Paired Samples t-Test (<0.05)

When comparing the pre-test and post-test mean scores of the shooting performance test within groups, a statistically significant improvement was observed in all groups ($p<0.05$).

The results of the changes in shooting performance test scores over time (pre-test and post-test difference) within groups and the comparisons between groups are presented in Table 4.

Table 4. Comparison of shooting performance test over time and between groups

	F	**η^2_p**	**p**
Time (Shooting Performance Test)	850.524	0.969	**<0.001**
Between Groups	10.525	0.438	**<0.001**
Time * Group Interaction	70.846	0.840	**<0.001**

p: Repeated Measures ANOVA Test ($p<0.05$), η^2p: (effect size)

According to the repeated measures ANOVA analysis, a statistically significant improvement in shooting performance test scores was observed over the course of the intervention (time) ($p<0.05$). Additionally, a significant difference was found between the groups in terms of shooting performance test results ($p<0.05$). The interaction between time and group (Time*Group) was also significant ($p<0.05$), indicating that some groups showed greater improvement compared to others.

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Based on these results, the statistical analysis of the comparisons between the groups is presented in Table 5.

Table 5. Post hoc analysis results of the shooting performance test between groups

Groups		**Difference**	**p**
Scapular Stabilization Group	PNF Group	2,05	0,155
Scapular Stabilization Group	Control Group	4,90	**<0,001**
PNF Group	Control Group	2,85	**0,034**

p: Tukey HSD (Post Hoc Test), Difference: The value between the groups' mean scores calculated as the average of pre-test and post-test results

According to the post hoc analysis results, no statistically significant difference was found between the scapular stabilization and PNF groups ($p>0.05$). When comparing the scapular stabilization group with the control group, a significantly greater improvement was observed in the scapular stabilization group ($p<0.05$). Similarly, a significant difference was found between the PNF group and the control group, with the PNF group showing greater improvement ($p<0.05$).

Discussion

This research explored the impact of scapular PNF and stabilization exercises on the shooting performance of archers aged 15 to 24. The results demonstrated that both intervention groups exhibited statistically significant improvements in performance compared to the control group. On the other hand, no meaningful statistical difference was observed between the experimental groups, indicating comparable outcomes from both interventions.

Archery is defined as a sport requiring the skill of shooting arrows at a target within a specified time frame, demanding a high level of technical proficiency and muscular control[30]. Physical fitness, technical ability, mental and psychological factors are among the core determinants of performance in archery[31]. Numerous techniques have been developed to enhance physical performance in various sports, including archery, with proprioceptive neuromuscular facilitation (PNF) and scapular stabilization exercises occupying a prominent place among them[17,32,33].

Particularly, PNF exercises aim to enhance neuromuscular response by stimulating proprioceptors and various studies in the literature have demonstrated their positive effects on joint range of motion and muscle performance[34,35].

The findings align with those reported in comparable studies within the existing literature. Studies by Bereket and Aras Bayram and Kazemi et al. reported that PNF and scapular stabilization exercises applied to young athletes improved shooting performance. Bereket and Aras Bayram demonstrated that upper extremity PNF and stabilization exercises performed on archers aged 9–14 enhanced their shooting performance[32,33]. Additionally, Kazemi et al. showed that an 8-week PNF exercise

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program significantly improved balance and sports functions in basketball players[33]. These studies align with our findings and suggest that PNF exercises can be effective for performance enhancement and development.

Additionally, some studies in the literature have shown that different PNF techniques increase throwing speed in various age groups and participants, which aligns with our findings[36,37]. Two separate studies have demonstrated the effectiveness of PNF exercises in treating scapular dyskinesis. In a study by Wagn and Qian, PNF exercises applied over four weeks were reported to correct scapular dyskinesis angle[38]. Another study by Ciğercioğlu et al. observed significant increases in the strength of the serratus anterior and lower trapezius muscles and improvements in scapular dyskinesis angle after six weeks of scapular PNF exercises in individuals with asymptomatic scapular dyskinesis[39]. The findings draw attention to the necessity of comprehensive shoulder and scapular functionality for accurate shooting. Therefore, the application of PNF exercises in cases of scapular issues or during training is likely to have a positive impact on performance, as seen in our study.

The primary aim of scapular stabilization exercises is to enhance stabilization by restoring the scapula's position, orientation, muscle movement control and movement patterns, thereby improving shoulder joint function[40]. Similar to our study, a case study in the literature applied scapular stabilization exercises to an archer athlete over eight weeks. After this period, improvements were observed in scapular angle, muscle strength, and scores on the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire. The study emphasized that these exercises could positively impact sports performance[17].

Studies by Karimi and Firouzjah (2024) and Eyvazi Hezebaran et al. (2021) have reported that scapular stabilization exercises applied to athletes with scapular dyskinesis reduce shoulder pain and enhance sport-specific performance[41,42]. Additionally, in individuals diagnosed with subacromial impingement syndrome, scapular stabilization exercises have been shown to improvement muscle power and produce significant improvements in scapular dyskinesis angle[43].

In this study, all three exercise groups demonstrated significant within-group improvements in shooting performance. However, the groups performing scapular PNF and scapular stabilization exercises in addition to routine exercises showed a statistically significant advantage over the control group (which performed only routine exercises). No statistically significant difference emerged between the PNF and SSE groups, suggesting comparable effectiveness of the two approaches.

However, this study has certain limitations. Firstly, the duration of the intervention and the intensity of the exercise programs were limited, and long-term effects need to be investigated. Additionally, due to the limited number of participants and age range, caution should be exercised when generalizing the results.

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Conclusion

The absence of a significant difference between the two experimental groups suggests that both exercise methods exert comparable effects on target shooting performance. This suggests that either exercise type can be applied depending on the individual needs and goals of the athletes. According to the study results, integrating PNF and scapular stabilization exercises systematically into training program is advised to improve archers' performance and reduce injury risk. The performance-enhancing, protective, and rehabilitative effects of these exercises should be considered. Future studies would benefit from investigating parameters such as muscle activation, scapular positioning, EMG analyses, proprioception and postural control with larger and more diverse samples. Additionally, the effects of applying these exercises together or sequentially, their applicability across different sports and their adaptation to individual differences represent important topics for further research.

Ethical Approval: Ethical approval for this study was obtained from the Non-Interventional Clinical Research Ethics Committee of Üsküdar University with the decision dated 28.10.2022 and numbered 61351342/October 2022-63. Additionally, a supplementary ethics approval was obtained on 26.05.2025 with the decision numbered 61351342/020-1167 for the revision of the thesis title during the research process.

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REFERENCES

1. Gözel Z. Okçuluk sporunun çocuklarda motor beceri ve dikkat üzerine etkisinin araştırılması. *Mediterranean Journal of Sport Science*. 2023;6(2):364-373.

2. Türker Ü. Olimpik okçuluk ve gelişim psikolojisi açısından incelenmesi. *Anatolia Sport Research*. 2020;1(1):5-24.

3. Vendrame E, Belluscio V, Truppa L, et al. Performance assessment in archery: A systematic review. *Sports Biomechanics*. 2022;1-23.

4. Kahya S. Sekiz haftalık kor egzersizlerinin makaralı okçuların atış performansına etkisi. *Sivas Cumhuriyet University Journal of Sport Sciences*. 2022;3(2):32-37.

5. Sarı PN, Çevik R, Çankaya T. Physical characteristics of the pulling and stabilization arm in archers, examination of posture and injury risk. *Turkish Journal of Kinesiology*. 2025;11(4):217-223.

6. Lin JJ, Hung CJ, Yang CC, et al. Activation and tremor of the shoulder muscles to the demands of an archery task. *Journal of Sports Sciences*. 2010;28(4):415-421.

7. Samur S. Spor kulüplerinde performans yönetimi. *Beden Eğitimi ve Spor Bilimleri Dergisi*. 2018;20(1):17-36.

8. Yu L. Focus on exercise physiology and sports performance. *Life*. 2025;15(1):84.

9. Susanto Siswantoyo Prasetyo Y, Putranta H. The effect of circuit training on physical fitness and archery accuracy in novice athletes. *Physical Activity Review*. 2021;9(1):100-8.

10. Handayani L, Kusnanik NW, Rusdiawan A, et al. Do the physical elements improving archery performance? *Retos: Nuevas Tendencias En Educación Física, Deporte y Recreación*. 2024;56:385-389.

11. Tunç S, Atılgan E, Algun C. Rotator manşet lezyonu olan olgularda üst ekstremite ve skapular proprioseptif nöromusküler fasilitasyon tekniğinin etkisi. *Fizyoterapi Rehabilitasyon*. 2019;30:40–47.

12. Aljallad M, Günday Ç, Badıllı Hantal FŞ. The acute effect of proprioceptive neuromuscular facilitation on cervical range of motion, strength, and proprioceptıon. *Türk Fizyoterapi ve Rehabilitasyon Dergisi*. 2024;35:315–323.

13. Balcı NC, Yuruk ZO, Zeybek A, et al. Acute effect of scapular proprioceptive neuromuscular facilitation (pnf) techniques and classic exercises in adhesive capsulitis: A randomized controlled trial. *Journal of Physical Therapy Science*. 2016;28(4):1219-1227.

14. Peteraitis T, Smedes F. Scapula motor control training with proprioceptive neuromuscular facilitation in chronic subacromial ımpingement syndrome: A case report. *Journal of Bodywork and Movement Therapies*. 2020;24(3):165-171.

15. Gorji SM, Kazemi O, Shahrzad P, et al. Efficacy of six weeks stability exercises on the glenohumeral joint of female tennis players with scapular dyskinesia. *International Journal of Exercise Science*. 2022;15(3):962-973.

16. Baltacı A. Nitel araştırmalarda örnekleme yöntemleri ve örnek hacmi sorunsalı üzerine kavramsal bir inceleme. *Bitlis Eren Üniversitesi Sosyal Bilimler Dergisi*. 2018;7(1):231-274.

17. Kim JT, Kim SY, Oh DW. An 8-week scapular stabilization exercise program in an elite archer with scapular dyskinesis presenting joint noise: A case report with one-year follow-up. *Physiotherapy Theory and Practice*. 2019;35(2):183-189.

18. Bezerra ES, Orssatto LBDR, Werlang LC, Generoso AM, Moraes G, Sakugawa RL. Effect of push-up variations performed with Swiss ball on muscle electromyographic amplitude in trained men: A cross-sectional study. *J Bodyw Mov Ther*. 2020;24(2):74-78.

19. Harput G, Güney Denİz H, Düzgün İ. Upper to middle trapezius muscle activation ratio during scapular retraction exercise at different shoulder abduction angles. *Türk Fizyoterapi ve Rehabilitasyon Dergisi*. 2017;28(3):111-117.

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20. Hotta GH, de Assis Couto AG, Cools AM, McQuade KJ, de Oliveira AS. Effects of adding scapular stabilization exercises to a periscapular strengthening exercise program in patients with subacromial pain syndrome: A randomized controlled trial. *Musculoskeletal Science and Practice*. 2020;49:102171.

21. Higgins M, Greer C. Proprioceptive neuromuscular facilitation for the upper extremity and scapula: Review and update on rehabilitation of shoulder pathology. *Int J Sports Phys Ther*. 2025;20(9):1407-1419.

22. Tedla JS, Sangadala DR. Proprioceptive neuromuscular facilitation techniques in adhesive capsulitis: A systematic review and meta-analysis. *J Musculoskelet Neuronal Interact*. 2019;19(4):482-491.

23. Tunç S, Atılgan E, Algün C. Rotator manşet lezyonu olan olgularda üst ekstremite ve skapular proprioseptif nöromusküler fasilitasyon tekniğinin etkisi. *Türk Fizyoterapi ve Rehabilitasyon Dergisi*. 2019;30(1):40-47.

24. Fukunaga T, Fedge C, Tyler T, et al. Band pull-apart exercise: Effects of movement direction and hand position on shoulder muscle activity. *International Journal Of Sports Physical Therapy*. 2022;17(3):400–408.

25. Grgic J, Schoenfeld BJ, Orazem J, et al. Effects of resistance training performed to repetition failure or non-failure on muscular strength and hypertrophy: A systematic review and meta-analysis. *Journal of Sport and Health Science*. 2021;10(5):593–601.

26. Baz-Valle E, Balsalobre-Fernández C, Santos-Concejero J, et al. The relationship between training volume and muscle hypertrophy in trained individuals: A systematic review and meta-analysis. *Journal of Strength and Conditioning Research*. 2022;36(5):1234–1242.

27. Escamilla RF, Yamashiro K, Paulos L, et al. Shoulder muscle activity and function in common shoulder rehabilitation exercises. *Sports Medicine*. 2009;39(8):663–685.

28. World Archery. Indoor archery. World Archery. https://www.worldarchery.sport/sport/disciplines/indoor-archery. Accessed Sep 20, 2024.

29. Muazu Musa R, Abdul Majeed APP, Taha Z, et al. A machine learning approach of predicting high potential archers by means of physical fitness ındicators. *PLOS ONE*. 2019;14(1):e0209638.

30. Scarzella F. Archery. In: Canata GL, Jones H, eds. *Epidemiology of Injuries in Sports*. Berlin, Heidelberg: Springer; 2022:1-6.

31. Kim HB, Kim SH, So WY. The relative importance of performance factors in Korean archery. *The Journal of Strength & Conditioning Research*. 2015;29(5):1211-1219.

32. Bereket E, Aras Bayram G. Proprioseptif nöromusküler fasilitasyon temelli üst ekstremite egzersizlerinin okçularda üst ekstremite fiziksel uygunluk parametreleri ve atış performansına etkisinin araştırılması. *Journal of Exercise Therapy and Rehabilitation*. 2022;9(2):92-100.

33. Kazemi A, Babakhani F, Sheikhhoseini R. et al. Effect of eight-week proprioceptive neuromuscular facilitation (PNF) pattern-based exercises on performance scores and postural stability in elite men basketball players. *Muscle Ligaments and Tendons Journal*. 2022;12(04):562.

34. Yin Y, Wang J, Lin Q, et al. Effect of proprioceptive neuromuscular facilitation on patients with chronic ankle instability: A systematic review and meta-analysis. *PLOS ONE*. 2025;20(1):e0311355.

35. Tonak HA, Büker N, Kitiş A, et al. Comparison of two different applications of proprioceptive neuromuscular facilitation techniques to increase upper-extremity muscle strength. *Bezmialem Science*. 2021;9(2):190-197.

36. Allred J, O'Brien K, Tran P. A Comparison of the effects on throwing velocity of straight plane versus diagonal plane shoulder exercises on 18-30 year old non-athletes. *Physical Therapy* Scholarly Projects. 2005;8.

37. Tekin D. Omuzda anterior ve posterior kapsül propriyoseptif nöromusküler fasilitasyon germe egzersizlerinin top fırlatma hızına akut etkisi. *Journal of Exercise Therapy and Rehabilitation*. 2021;8(1):18-28.

38. Wang S, Qian J. Effect of PNF exercise on the rehabilitation of scapula dyskinesis. *Journal of Kunming Medical University / Kunming Yike Daxue Xuebao*. 2020;41(1):112-118.

39. Ciğercioğlu NB, Ünüvar E, Hazimlioglu P, et al. Proprioceptive neuromuscular facilitation training ımproves scapular muscle strength and pectoralis minor length in individuals with scapular dyskinesis. *Journal of Basic and Clinical Health Sciences*. 2022;6(1):238-246.

40. Tang L, Chen K, Ma Y, et al. Scapular stabilization exercise based on the type of scapular dyskinesis versus traditional rehabilitation training in the treatment of periarthritis of the shoulder: Study protocol for a randomized controlled trial. *Trials*. 2021;22:1-11.

41. Karimi R, Mohammad Ali Nasab Firouzjah E. Impact of scapular stabilization exercises on pain, shoulder position, and volleyball performance in players with scapular dyskinesia. *Journal of Rehabilitation Sciences & Research*. 2024;11(3):132-138.

42. Eyvazi Hezebaran A, Ghani Zadeh Hesar N, Mohammad Ali Nasab Firouzjah E, Roshani S. Effect of eight weeks scapular stabilization exercises on shoulder pain

of archer men with scapular dyskinesis: A clinical trial study. *Journal of Gorgan University of Medical Sciences*. 2021;23(3):24-31.

43. Başkurt Z, Başkurt F, Gelecek N, et al. The effectiveness of scapular stabilization exercise in the patients with subacromial ımpingement syndrome. *Journal of Back and Musculoskeletal Rehabilitation*. 2011;24(3):173-179.

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