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The Effect of Regular Exercising on Shoulder Pain and Scapular Endurance

Düzenli Egzersizin Omuz Ağrısı ve Skapular Kassal Endurans Üzerine Etkisi

Aziz DENGİZ[1] Nilüfer CETİSLİ KORKMAZ[2] Esra DOGRU HÜZMELİ[3]

ÖZ

Amaç: Serratus anterior ve trapezius kasları, skapulotorasik eklemin en önemli stabilizatörleridir. Bu kasların yetersiz enduransı, nöro-musküler performansta azalmaya neden olabilir. Bu çalışmanın amacı, genç bireylerde düzenli egzersizin skapular kas dayanıklılığı ve omuz ağrısı üzerindeki etkilerini incelemektir.
Araçlar ve Yöntem: Bu çalışma kesitsel bir çalışma olarak tasarlandı. Katılımcıların klinik ve sosyodemografik özellikleri oluşturulan sosyodemografik veriler formuyla, skapular kas enduransı Skapular Kassal Endurans testi ile ve omuz ağrısı şiddeti Visual Analog Skalası ile değerlendirildi.
Bulgular: Çalışmaya düzenli egzersiz yapan 100 katılımcı (38 kadın, yaş ortalaması 21.37±0.23 yıl) ve sedanter yaşayan 100 katılımcı (55 kadın, yaş ortalaması 21.21±0.20 yıl) dahil edildi. Düzenli egzersiz grubu 3.120±2.434 yıl boyunca haftada ortalama 3.110±0.166 gün egzersiz yaptığını bildirmiştir. Katılımcılar, ağrısı olan ve olmayan olarak gruplara ayrıldı. Skapular endurans değerleri, ağrısı olan ve olmayan sedanter grup ile düzenli egzersiz yapan grup arasında karşılaştırıldı. Tüm gruplarda Skapular kassal endurans değerleri, düzenli egzersiz yapan grupta anlamlı derecede yüksek bulundu (p=0.001). Ancak, omuz ağrısı skorları açısından gruplar arasında anlamlı bir farklılık saptanmadı (dinlenme ve aktivite srasında ağrı p=0.925 ve p=0.886).
Sonuç: Düzenli egzersizin, skapular kas enduransını artırmada önemli bir rol oynadığı ve ilerleyen yaşlarda omuz problemlerinin önlenmesi açısından erken yaşlarda egzersiz bilincinin yaygınlaştırılması gerektiği sonucuna varılmıştır.

Anahtar Kelimeler: genç erişkin; serratus anterior kası; stabilizasyon; omuz ağrısı

ABSTRACT

Purpose: Serratus anterior and trapezius muscles are the most important stabilizers of the scapulathoracic joint. Inadequate endurance of these muscles plays a crucial role in reduced neuromuscular performance. The aim of this study was to investigate the effects of regular exercise on scapular muscle endurance and shoulder pain in young individuals.
Materials and Methods: This study was designed cross sectional study. Participants' clinical and socio-demographic characteristics were documented, the Scapular Muscular Endurance (SME) test was employed to evaluate SME, and shoulder pain was assessed using the Visual Analogue Scale.
Results: One hundred participants exercising regularly (38 females, mean age 21.37±0.23 years) and 100 sedentary participants (55 females, mean age 21.21±0.20 years) were included. The regular exercise group reported an average of 3.110±0.166 days per week for 3.120±2.434 years. Participants were divided into two groups: those who had pain and those who did not. Scapular endurance of the regular exercising group and the sedentary group with pain and without pain was compared. In all groups, SME was found to be higher in favour of the regularly exercising group (p=0.001). The groups were not shown significant in terms of shoulder pain pain at rest and during activity p=0.925 and p=0.886).
Conclusions: It was concluded that regular exercise plays an important role in increasing scapular muscle endurance and that exercise awareness should be promoted at an early age in order to prevent shoulder problems in the future.

Keywords: serratus anterior muscle; stabilization; shoulder pain; young adult

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[1]Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Mus Alparslan University, Mus, Türkiye.
[2]School of Physical Therapy and Rehabilitation, Pamukkale University, Denizli, Türkiye.
[3]School of Physical Therapy and Rehabilitation, Mustafa Kemal University, Hatay, Türkiye.
Corresponding Author: Aziz Dengiz, Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Mus Alparslan University, Mus, Türkiye.
e-mail: ptazizdengiz@gmail.com

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INTRODUCTION

The endurance of scapular muscles is essential for sustaining shoulder stability, especially during repetitive arm movements or extended overhead activity. The serratus anterior, trapezius, and rhomboids are crucial muscles for regulating the posture and movement of the scapula. Muscle weakness or exhaustion may cause scapular dyskinesis, disrupting the usual movement patterns of the scapula, which can lead to shoulder pain, impingement, and diminished function.[1,2] Muscle fatigue, especially during extended or repetitive tasks, heightens the likelihood of scapular winging and instability, thereby undermining shoulder biomechanics and resulting in conditions like rotator cuff injury.[3]

Dysfunction of the scapular muscles may disrupt the normal posture and mechanics of the scapula. The disparity between the dominant pectoralis minor muscle and the weaker middle trapezius muscle results in postural deviation of the shoulders, leading to neck and upper back pain over time. The weakening of the scapular muscles causes premature fatigue, resulting in insufficient stability of the scapula.[4] The scapular area and shoulder girdle experience mechanical issues that result in diminished strength and endurance, changed activation, and consequently adverse effects such as pain, aberrant scapular movements, higher shoulder loads, and compromised functionality. The serratus anterior and trapezius muscles serve as essential stabilisers of the scapulothoracic joint. Preserving sufficient muscle endurance is essential for the prevention of shoulder pain. The inadequate endurance of these muscles leads to diminished neuromuscular function and the emergence of shoulder joint problems.[5,6]

Numerous treatments and diverse exercises have been developed and researched to target specific regions of the scapular and shoulder muscles to alleviate pain and improve overall function with the goal of optimizing scapular position and scapulohumeral rhythm. Ultimately, the strength and integrity of shoulder movement are a consequence of the scapular control, endurance, and stability.[7] Regular exercising is one of the most important parameters that could be accepted as a cornerstone. Many studies have reported that regular exercise improves muscle strength, muscle endurance, stability and balance, and reduce pain.[8,9] Meanwhile, there is a lack of evidence on the effectiveness of regular exercising for non-specific shoulder pain and scapular muscles' endurance. The research measuring the potential reductions in shoulder pain following regular exercise focusing on specific muscles of the shoulder girdle, such as scapular muscles, is also lack.[10] The primary aim of this study was to examine the impact of regular exercise on scapular muscle endurance (SME) and shoulder pain in young individuals.

MATERIALS and METHODS

Ethics Approval

Ethical considerations were meticulously addressed throughout the study. All participants gave written informed consent before participating in the study and the principles of the Declaration of Helsinki were followed. This study was approved by Hatay Mustafa Kemal University Tayfur Ata Sökmen Medical Faculty Clinical Research Ethics Committee (dated 07/02/2014 and numbered 4298783/05022/4). To ensure transparency and compliance with reporting standards.

Participants

The sociodemographic data including age, gender, body mass index (BMI), dominance, smoking habit, and exercise frequency was questioned. A total of 200 individuals aged between 17 and 25 years. The regular exercisers group comprised young adults aged 18 to 25 who exercised regularly, primarily at gyms, but were not professional athletes. Eligible participants had no history of significant shoulder injuries, surgeries, or major musculoskeletal disorders affecting the shoulder or scapular region. Informed consent was obtained from all participants before their inclusion.

Participants were excluded if they had any neurological disorders or systemic diseases that could have affected muscle function. This included a history of severe cardiovascular or respiratory conditions. Individuals with recent injuries to the shoulder, neck, or upper back (within the past six months),

or those who had undergone surgical interventions impacting the scapula, shoulder, or upper limbs, were also excluded. Additionally, participants who were involved in other physical therapy or exercise programs that might have influenced shoulder function, or who were engaged in professional sports or intensive upper body activities, were not eligible for the study.

Outcome Measurements

Shoulder pain severity was assessed using the Visual Analogue Scale (VAS), postural alignment was evaluated through postural analysis and a muscle shortness test, muscle strength was measured using the Manual Muscle Test, and scapular endurance was assessed with the Scapular Muscles Endurance (SME) test for the serratus anterior muscle.

Pain intensity in the shoulder was rated using the VAS, a numerical scale ranging from 0 to 10 points, where 0 indicated no pain and 10 represented the highest pain level. Participants marked the point on the scale that best reflected their shoulder pain severity, allowing for a quantitative assessment of pain intensity.[11]

Postural analysis aimed to identify postural deviations to guide tailored treatment and exercise programs.[12] This assessment was performed with participants standing comfortably in bare feet and suitable attire. The lumbar spine, latissimus dorsi, pectoralis major, external shoulder rotators, and internal rotators were manually examined for muscle shortness and noted accordingly.[13]

The Manual Muscle Test was applied to assess the strength of key muscle groups, including the serratus anterior, latissimus dorsi, trunk extensors, shoulder flexors, horizontal adductors, and both external and internal shoulder rotators.[14]

Scapular endurance was evaluated using the SME test on the serratus anterior muscle. During this test, participants stood with their shoulders and elbows flexed at 90 degrees, without their arms touching the wall. To ensure standardized positioning, participants held a green elastic exercise band that provided 2.3 kg of resistance at 100% stretch, with an adjustable ruler placed between the elbows to maintain alignment. Participants were instructed to maintain neutral scapular positioning and external shoulder rotation for as long as possible. The time they sustained the resistance was recorded in seconds. The test concluded if the participant dropped the ruler, could no longer maintain 90 degrees of shoulder flexion, or reported intolerable discomfort.[15]

Randomization

None

Sample size

It was calculated that 95% power could be obtained at 95% confidence level when at least 176 people (88 people for each group) were included in the study (cohen's d effect size=0.5).

Statistical Analysis

The Statistical Package for the Social Sciences (SPSS 23.0, SPSS Inc., Chicago, IL) was used to conduct the statistical analyses. Continuous data was presented as mean and standard deviation or median and interquartile range percentiles. The Kolmogorov Smirnov test, skewness, and kurtosis values were used to evaluate the normality of all continuous variables. To examine significant differences in qualitative demographic data between the two groups, the chi-square test was employed. Additionally, for significant differences between the Regular Exercising and Sedentary groups, the student's t-test was utilized. The level of significance was set at $p<0.05$.

RESULTS

The demographic characteristics of the sedentary and regular exercising groups are summarized in Table 1. One hundred participants exercising regularly (38 females, mean age 21.37±0.23 years) and 100 sedentary participants (55 females, mean age 21.21±0.20 years) (χ^2=5.808, p=0.016). Both groups were similar in terms of age, weight, and BMI (p=0.598, p=0.467, and p=0.564, respectively, as shown in

Table 1), with the exception of height, which differed significantly (p=0.016, Table 1). Participants in the regular exercising group reported exercising an average of 3.110±0.166 days per week for 3.120±2.434 years.

A significant advantage was observed in SME for the regular exercising group, with higher scores compared to the sedentary group (p=0.001, Table 2). Participants were further analyzed based on whether they experienced pain during activity or at rest. Across all subgroups, the regular exercising group consistently demonstrated significantly higher mean SME scores than the sedentary group (p=0.001, Table 2).

Table 1. Demographic properties of groups.

Variables	Regular Exercise Mean ± SD	Sedentary Mean ± SD	t	p
Age (years)	21.370±2.316	21.210±1.955	0.528	0.598
Weight (kg)	65.010±9.562	63.840±12.876	0.729	0.467
Height (cm)	171.700±7.698	168.980±8.072	2.438	**0.016***
BMI (kg/m2)	21.979±2.275	22.212±3.315	0.578	0.564

BMI: Body Mass Index, t: Student's Test, SD: Standard deviation, *p<0.05.

Table 2. Scapular muscle endurance scores for participants with and without shoulder pain during rest and activity.

Variables		Scapular Muscle Endurance					
		Regular Exercise		Sedentary			
		n	Mean ± SD	n	Mean ± SD	t	p
Participants with	**All**	100	74.370±16.626	100	52.180±10.167	11.386	**0.001***
	Pain in activity	15	71.466±22.057	19	49.105±9.596	3.979	**0.001***
	No pain in activity	85	74.882±15.586	81	52.901±10.219	10.690	**0.001***
	Pain in rest	10	76.200±25.213	14	48.142±2.719	3.781	**0.001***
	No pain in rest	90	74.166±15.581	86	52.837±10.072	10.731	**0.001***

t: Student's t Test, SD: Standard deviation, *p<0.05.

No significant differences were found between the groups for posture and manual muscle test scores. Similarly, pain scores during activity and at rest did not differ significantly (p=0.925 and p=0.886, respectively, as shown in Table 3). However, more participants in the sedentary group displayed a positive finding for shortness in the right and left pectoralis major and internal rotator muscles (p<0.05), with no such cases of shortness in the regular exercising group (Regular Exercising Group shortness n= 0, Sedentary Group shortness n=18). Despite these findings, postural analysis revealed no significant differences between the two groups (p>0.05).

Table 3. Shoulder pain severity in activity and rest.

Variables	Regular Exercise Mean ± SD	Sedentary Mean ± SD	t	p
Shoulder pain in activity	0.710± 1.793	0.690± 1.643	0.820	0.925
Shoulder pain in rest	0.300± 1.010	0.320± 0.952	0.144	0.886

t: Student's t -Test, SD: Standard deviation, *p<0.05.

DISCUSSION

This study aimed to explore the effects of regular exercise on SME and shoulder pain. The findings revealed that participants who exercised regularly had significantly higher scapular endurance, while no significant difference in pain levels was observed between groups. Previous research has consistently shown that regular exercise enhances muscle strength and endurance while reducing pain.[16,17] However, there remains a gap in the literature, particularly regarding studies that specifically target muscle groups like the trapezius and serratus anterior.[18] While it's well-known that elite athletes develop adaptations in muscle function and joint stability after years of specialized training, recent studies suggest that similar benefits can also be seen in recreational athletes who maintain consistent training over time.[19] However, research on the effects of regular exercise on scapular endurance in non-athlete individuals remains limited, highlighting a need for more studies in this area. This study is valuable because it investigates the influence of regular exercise on shoulder pain and scapular endurance in young adults who are not professional athletes. Our findings showed a clear advantage in the regularly exercising group across all parameters of SME, supporting the idea that consistent exercise improves SME,

which is crucial for healthy shoulder mechanics and injury prevention. Moreover, recent studies indicate that SME assessment could be a practical and cost-effective tool for evaluating shoulder function, especially in preventive healthcare settings.[20] These findings emphasize that general fitness exercises, not limited to scapular-specific routines, may provide significant benefits for musculoskeletal health.

A sedentary lifestyle can lead to various health problems, including obesity and musculoskeletal disorders.[21] Muscle and bone deterioration are common consequences of inactivity, and studies have shown that a 20% decline in handgrip strength can occur after just one week of bed rest in healthy adults.[21] In our study, the regularly exercising group demonstrated significantly better SME compared to their sedentary counterparts, which could help mitigate future musculoskeletal problems. These results are in line with other studies that highlight the protective effects of regular exercise against musculoskeletal conditions.[22,23]

Scapulothoracic stability relies on the coordinated activity of muscles like the serratus anterior and trapezius, which are essential for proper shoulder movement. Dysfunction in these muscles can lead to abnormal scapular mechanics, affecting neuromuscular function and increasing the risk of shoulder injuries. Recent research has confirmed that targeted exercises can enhance scapular stability and prevent shoulder dysfunction in recreational athletes.[24,25] Our study supports the view that general exercise, whether performed in a fitness center or as part of a rehabilitation program, may improve scapular endurance and reduce the risk of chronic pain and injuries. Normal scapular mot ion requires a balanced combination of external and upward rotation, shifting from an anterior to a posterior tilt as humeral elevation increases. This coordinated movement is regulated by the serratus anterior and trapezius muscles working in tandem.[26] A study comparing gymnasts to non-athletic adolescents found that gymnasts had superior protraction strength and better muscular balance, illustrating the benefits of regular training on scapular function.[27] However, recent evidence suggests that non-athletes can achieve similar improvements through consistent moderate exercise, challenging the notion that only elite training provides significant benefits.[28]

The prevalence of neck and shoulder pain is well-established among sedentary adults, but the incidence among healthy young adults is largely underreported. Numerous studies have suggested a link between shoulder abnormalities, abnormal scapular movements, and generalized weakness in the scapulothoracic muscles.[29] In contrast, some researchers attribute scapular dyskinesis to muscle imbalances rather than an overall deficit in strength. Specifically, excessive activation of the upper trapezius, coupled with reduced control of the lower trapezius and serratus anterior, has been proposed as a key contributor to abnormal scapular motion.[30] In this context, adequate muscular endurance is essential to counteract these dysfunctions.[31] In our study, the young adults who exercised regularly did not have diagnosed shoulder pathologies or pain, which may have contributed to a lower incidence of shoulder pain compared to the sedentary group. Additionally, our results showed that individuals who exercised regularly had better muscular endurance and did not experience additional discomfort in the shoulder girdle during activity or at rest. This is consistent with previous research, which has demonstrated no direct relationship between physical activity levels and shoulder pain.[32] Furthermore, it has been established that exercise can improve concentration and reduce the perception of pain.[33,34] However, questions remain as to whether more targeted shoulder and thoracic exercises, a more precise study sample, extended exercise duration, or adopting regular exercise as a long-term lifestyle choice would lead to even greater reductions in shoulder pain.[10] Future studies should investigate the effects of these factors to better understand their impact on shoulder health.

Scapular muscle dysfunction can lead to improper shoulder mechanics, fatigue, poor stabilization, and functional limitations.[20,32] Our findings indicated that the regularly exercising group had significantly better serratus anterior endurance across all conditions, suggesting that general exercise may help prevent serratus anterior weakness. This conclusion aligns with existing research that emphasizes the importance

of serratus anterior strength for shoulder stability, especially in individuals at risk for shoulder dysfunction.[35] Emerging studies also indicate that enhancing scapular endurance can help reduce neck pain associated with shoulder dysfunction. As neck pain often stems from soft tissue changes, maintaining scapular endurance may help prevent secondary complications.[36,37] Routine scapular endurance assessments could therefore be an effective screening tool for early detection of shoulder issues, particularly in routine check-ups for healthy individuals.

Future research should focus on comparing the outcomes of specific versus general exercise programs on scapular endurance and their long-term impact on musculoskeletal health. Long-term studies are needed to assess whether consistent, moderate exercise can effectively prevent the development of shoulder disorders over time.

Limitations

The main limitation of this study was having cross-sectional design rather than a longitudinal study. Therefore, additional studies with periodic follow-up of the participants are needed to clarify the existing findings. Furthermore, the observed improvements were merely a reflection of the natural recovery of doing exercise regularly. The type of exercise was not questioned, due to the lack of a control group that had done specific scapular exercises, so it is unclear if the observed improvements would be more with the predetermined and specific exercise effect. Therefore, future randomized controlled studies could focus on the predetermined and specific scapular and shoulder girdle exercises and could also compare the individuals who were doing scapular exercises or exercises for the whole body.

Our results suggest that measuring scapular muscles' endurance and shoulder pain as a potential effect of doing exercise regularly is essential. SME was recorded higher in young individuals who were exercising regularly. With this evidence, future research should evaluate potential changes in scapular muscles' endurance after predetermined, specific and individualized exercise programs. We concluded that awareness of exercising regularly from the young ages should be raised to emphasize the importance of exercising regularly. Furthermore, keeping the endurance level of the scapular muscles at a certain level has a significant role for the shoulder biomechanics, and is important to improve the dynamic control of the shoulder in addition to the prevention of the shoulder pain. We could suggest that, to prevent the potentially harmful and unwanted consequences, balanced decision-making should be created by considering the preferences of professionals focusing on this area, the exercising individuals' preferences, and adherence of them to the chosen program regularly.

Conflict of Interest

The authors declare that there is not any conflict of inter-est regarding the publication of this manuscript.

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Ethics Committee Permission

This study was approved by Hatay Mustafa Kemal University Tayfur Ata Sökmen Medical Faculty Clinical Research Ethics Committee (dated 07/02/2014 and numbered 4298783/05022/4).

Authors' Contributions

Concept/Design: AD, NÇK. Data Collection and/or Processing: AD, EDH. Data analysis and interpretation: AD, NÇK, EDH. Literature Search: AD, NÇK. Drafting manuscript:

AD, NÇK, EDH. Critical revision of manuscript: NÇK. Supervison: NÇK.

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