Effects of Pilates Apparatus-Based Stretching Exercises for the Back and Spine on Balance Control Ability, Upper Trapezius Muscle Tension, and Forced Vital Capacity (FVC) in Healthy Adults.

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필라테스 기구를 이용한 등과 척추 스트레칭 운동이 정상 성인의 균형조절능력과 Upper Trapezius 근육의 긴장도, 그리고 총폐활량(FVC)에 미치는 영향

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Abstract

Purpose: The aim of this study was to examine the effects of Pilates equipment-based back and spine stretching exercises on balance control ability, upper trapezius muscle tension, and total vital capacity (FVC) in healthy adults.

Methods: This study included 16 undergraduate students enrolled at S University in Chungnam. Balance ability was measured using Tetrax, while respiratory capacity was assessed using a spirometer. The muscle tension of the upper trapezius was evaluated using myotone at pressure points.

Results: After stretching, a significant difference in balance was observed only when participants had their eyes closed among the stability indices ($p < 0.05$). Furthermore, significant differences were found in both upper trapezius muscle tone and forced vital capacity (FVC) after stretching ($p < 0.05$). During the follow-up period, a significant difference was observed only in FVC ($p < 0.05$).

Conclusion: Stretching exercises performed with Pilates equipment have a significant impact on balance, muscle tone, and respiratory capacity

1. Introduction

In modern society, many tasks can only be solved using computers, leading to an increase in the time spent sitting in front of them [1]. This sedentary behavior is associated with the onset of musculoskeletal diseases, particularly in areas such as the neck , waist, shoulders, and back, which are commonly affected by computer-related work [2][3][4].

The importance of stretching is emphasized as a solution to these problems. It relieves muscle tension, reduces pain, and contributes to improved function and quality of life [5][6]. In particular, applying stretching to individuals with back pain reduces pain and improves function and quality of life. Stretching of the thoracic and lumbar spine can improve the function of daily living activities by increasing joint range of motion [7][8][9]. Even in cases of back and neck pain, stretching has been shown to have a positive effect on reducing pain [5][6]. These stretches can effectively reduce both acute and chronic pain, which may be attributed to pain control mechanisms [10].

Among stretching methods, the Pilates method significantly increases muscle activation and can also positively improve balance, flexibility, and cardiorespiratory capacity [11][12][13][14]. Based on previous research results, we plan to apply a stretching method using Pilates equipment [15].

This study suggests the possibility of clinical use of Pilates equipment and will contribute to the development of effective prevention and management strategies for back and spine health. Therefore, the purpose of this study was to investigate the effects of back and spine stretching exercises using Pilates equipment on balance control ability, upper trapezius muscle tension, and total

vital capacity (FVC) in normal adults.

2. Subjerct and methods

2.1 Subject

This study was conducted on 16 college students attending S University in Chungcheongnam-do. The age was 22.00 ± 2.22 ears, height was 172.56 ± 5.03 cm and body weight was 75.67 ± 14.21 kg [Table 1].

2.2 Study procedure

In this study, back and spine stretching was performed using two stretching devices. The first device, the Advanced Split (Motion Care Company, Korea), was used to stretch the general back muscles. The second device, the Wholebody Spineback (Motion Care Company, Korea), was applied to stretch the spine and overall anterior trunk muscles. Stretching using each device consisted of 3 sets of 12 repetitions, with 1 minute of rest between sets. The total stretching time was 20 minutes. All exercises were performed after detailed training to the participants in advance.

Measurements were taken a total of three times before intervention, after stretching, and follow-up. Balance ability was measured using Tetrax and respiratory rate was measured using a spirometer. Muscle tone was evaluated at the tender point of the upper trapezius using myotone.

2.3 Statistical analysis

SPSS for Windows (version 22.0) was used to analyze the data in this study. Normality was assessed using a normality test.

One-way repeated measures ANOVA was conducted to determine differences according to the intervention period (before, after, and follow-up), and Fisher's LSD (Least Significant Difference) test was used for post-hoc comparisons. The level of statistical significance was set at $\alpha = .05$.

3. Results

After stretching, a significant difference in the change in balance control ability was observed only in the ST_EC group ($p < 0.05$).

There was a significant decrease in post-stretching compared to pre-stretching, and a significant difference was also observed between follow-up and post values ($p < 0.05$, see Table 2).

After stretching, significant differences were observed in both upper trapezius muscle tone and FVC ($p < 0.05$).

There was a significant decrease in upper trapezius muscle tone post-stretching compared to pre-stretching ($p < 0.05$, see Table 3).

Following stretching, FVC significantly increased in post-stretching and follow-up compared to pre-stretching, and there was also a significant difference between follow-up and post values ($p < 0.05$, see Table 3).

[Table 1] The General subject characteristics

Variable	N=16
Age(year)	22.00±2.22
Height(㎝)	172.56±5.03
Weight(㎏)	75.67±14.21

Mean±SDa

[Table 2] Changes in balance control after stretching

	pre	post	Follow-up	F	p	effect size(η2)
WDI_EO	3.44±1.35	3.79±1.18	3.74±1.47	2.56	0.092	0.131
WDI_EC	3.79±1.17	4.25±1.05	4.04±1.54	2.23	0.115	0.060
ST_EO	15.42±2.29	15.93±4.20	15.32±2.87	0.26	0.770	0.015
ST_EC	17.98±3.04b	17.12±2.54ac	17.90±2.11b	3.89	0.025*	0.100

*p<0.05 (Mean±SD), EO: eye open, EC: eye close, a Statistically different from pre, b Statistically different from post, c Statistically different from Follow-up.

[Table 3] Correlation between lower extremity muscle strength and balance ability

	pre	post	Follow-up	F	p	effect size(η2)
Upper Trapezius muscle tone(Hz)	24.89±1.17b	24.32±1.55a	24.48±1.50	4.47	0.015*	0.113
FVC	4.65±1.41bc	5.12±0.52a	4.97±1.11a	4.56	0.014*	0.115

*p<0.05 (Mean±SD), FVC: Forced vital capacity, a Statistically different from pre, b Statistically different from post, c Statistically different from Follow-up.

4. Conclusion

In conclusion, back and spine stretching using Pilates equipment improved the Stability Index among the balance control abilities in the eyes-closed state, and the tension of the Upper Trapezius muscle also significantly decreased. Additionally, there was a

significant improvement in total vital capacity (FVC), the improved lung capacity was maintained even after one week. According to the results of this study, stretching the back and spine using Pilates equipment can have a positive effect on balance, muscle tone, and breathing rate.

References

[1] Barsawade, V., Dangare, S., Jagadale, R., & Magdum, S. A. (2019). Study on Incorrect Sitting & Standing Posture and its Implication on Neck Pain. International Research Journal of Engineering and Technology, 6(5).

[2] Malińska, M. (2019). Dolegliwości układu mięśniowo-szkieletowego u operatorów komputerowych. Medycyna Pracy, 70(4), 511-521.

[3] Noroozi, M. V., Hajibabaei, M., Saki, A., & Memari, Z. (2015). Prevalence of musculoskeletal disorders among office workers. Jundishapur journal of health sciences, 7(1).

[4] Putsa, B., Jalayondeja, W., Mekhora, K., Bhuanantanondh, P., & Jalayondeja, C. (2022). Factors associated with reduced risk of musculoskeletal disorders among office workers: a cross-sectional study 2017 to 2020. BMC Public Health, 22(1), 1503.

[5] Mansoori, S. S., Moustafa, I. M., Ahbouch, A., & Harrison, D. E. (2021). Optimal duration of stretching exercise in patients with chronic myofascial pain syndrome: A randomized controlled trial. Journal of Rehabilitation Medicine, 53(1).

[6] Silva Filho, J. N. D., Gurgel, J. L., & Porto, F. (2020). Influence of stretching exercises in musculoskeletal pain in nursing professionals. Fisioterapia em Movimento, 33, e003317.

[7] Stankovic, A., Lazovic, M., Kocic, M., Dimitrijevic, L., Stankovic, I., Zlatanovic, D., & Dimitrijevic, I. (2012). Lumbar stabilization exercises in addition to strengthening and stretching exercises reduce pain and increase function in patients with chronic low back pain: randomized clinical open-label study. Turkish Journal of Physical Medicine & Rehabilitation/Turkiye Fiziksel Tip ve Rehabilitasyon Dergisi, 58(3).

[8] Chan, E. W. M., Adnan, R., & Azmi, R. (2019). Effectiveness of core stability training and dynamic stretching in rehabilitation of chronic low back pain patients. Malaysian Journal of Movement, Health & Exercise, 8(1), 1-13.

[9] Hatefi, M., Babakhani, F., & Ashrafizadeh, M. (2021). The effect of static stretching exercises on hip range of motion, pain, and disability in patients with non-specific low back pain. Journal of experimental orthopaedics, 8, 1-6.

[10] Behm, D. G., Kay, A. D., Trajano, G. S., Alizadeh, S., & Blazevich, A. J. (2021). Effects of acute and chronic stretching on pain control. Journal of Clinical Exercise Physiology, 10(4), 150-159.

[11] Johnson, E. G., Larsen, A., Ozawa, H., Wilson, C. A., & Kennedy, K. L. (2007). The effects of Pilates-based exercise on dynamic balance in healthy adults. Journal of bodywork and movement therapies, 11(3), 238-242.

[12] Moreno-Segura, N., Igual-Camacho, C., Ballester-Gil, Y., Blasco-Igual, M. C., & Blasco, J. M. (2018). The Effects of the Pilates Training Method on Balance and Falls of Older Adults: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. Journal of Aging & Physical Activity, 26(2).

[13] Rayes, A. B. R., de Lira, C. A. B., Viana, R. B., Benedito-Silva, A. A., Vancini, R. L., Mascarin, N., & Andrade, M. S. (2019). The effects of Pilates vs. aerobic training on cardiorespiratory fitness, isokinetic muscular strength, body composition, and functional tasks outcomes for individuals who are overweight/obese: a clinical trial. PeerJ, 7, e6022.

[14] Stasiu, V., Ferreira, L. A. B., Athaus, M., Pereira, J., dos Santos, F. S., Stadler, P., ... & Pereira, W. M. (2019). Effect of stretching through the pilates method–controlled, randomized clinical study. Manual Therapy, Posturology & Rehabilitation Journal, 1-7.

[15] Cruz-Díaz, D., Bergamin, M., Gobbo, S., Martínez-Amat, A., & Hita-Contreras, F. (2017). Comparative effects of 12 weeks of equipment based and mat Pilates in patients with Chronic Low Back Pain on pain, function and transversus abdominis activation. A randomized controlled trial. Complementary therapies in medicine, 33, 72-77.