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Original Article

Influence of pilates training on the quality of life of chronic stroke patients

Seok-Min Yun, PhD[1)], Sang-Kyoon Park, PhD[2)], Hee Sung Lim, PhD[3)*]

[1)] *Department of Rehabilitation Sports Lab, Korea Nazarene University, Republic of Korea*
[2)] *Department of Physical Education, Korea National Sport University, Republic of Korea*
[3)] *Department of Physical Therapy, Gang Dong University: Janghowon-Eup Post Office Box-1, Inchen-si 138-763, Republic of Korea*

Abstract. [Purpose] This study was to observe the influence of Pilates training on the quality of life in chronic stoke patients. [Subjects and Methods] Forty chronic stroke patients participated in this study. They were divided into same number of experimental group (EG) and control group (CG). EG participated in a 60-min Pilates training program, twice a week for 12 weeks, while the CG did not participate in any exercise-related activities for the duration and participating in general occupational therapy without any exercise-related activities. Then the MMSE-K was performed before and after Pilates training to observe the influence of Pilates training on the quality of life in chronic stroke patients. [Results] Statistically significant improvement in the physical, social, and psychological domains was found in EG after the training. No statistically significant difference was found in all three quality of life domains for the CG. EG experienced a statistically significant improvement in all quality of life domains compared with that of CG. [Conclusion] Therefore, participation in Pilates training was found to effectively improve the quality of life in stroke patients. Pilates training involves low and intermediate intensity resistance and repetition that match the patient's physical ability and can be a remedial exercise program that can improve physical ability and influence quality of life.

Key words: Stroke, Pilates training, Quality of life

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INTRODUCTION

Stroke is a chronic disorder that is mainly caused by a decrease in the number of brain cells, resulting from lack of oxygen due to a blockage or rupture in cerebral blood flow[1)]. Furthermore, stroke is the second highest cause of death after cancer, with 17 million occurrences annually worldwide. It is also the disorder with the third highest proportion of disability occurrences, with numbers increasing annually[2)]. There are varying disabilities found in >85% of patients surviving stroke, including physical disabilities due to stiffness, lack of physical coordination, or sensory paralysis, decrease in intellectual abilities due to decreased focus or memory loss and other language disabilities, mental disabilities due to sense of loss, etc[3, 4)].

In 1997, the World Health Organization (WHO) defined "quality of life" as a person's views regarding their position in society, including physical, social, and psychological domains. Moreover, they stated that higher or lower quality of life is determined according to an individual's health, lifestyle and satisfaction, psychological and mental state, independence, social environment, etc[5)]. Therefore, the quality of life in the majority of stroke patients, who are limited in their ability to perform basic activities that are inherent to "quality of life" that is greatly influenced by a person's health or disorder, was found to be remarkably low[6–10)]. After being discharged from the hospital, patients who had stroke are typically unable to participate in consistent rehabilitation training to recover their functionality due to time and financial difficulties. As a result,

*Corresponding author. Hee Sung Lim (E-mail: hslim2002@hotmail.com)

patients often experience decreased will and tend to live on their own without any social relations. Such results show that stroke patients experience decreased quality of life from the physical, mental, and social perspectives after onset, and their quality of life drastically decreases for 4 years after the stroke[8, 11].

The rehabilitative objective of stroke patients is based on independent living by improving their functional disabilities[12]. Therefore, rehabilitation training for stroke patients focuses on improving flexibility, muscular strength, coordination, and sense of balance to maintain an independent lifestyle through the recovery of physical functions; thus, requiring consistent and long-term treatment[13, 14]. However, a method that promotes the meaning of life and qualitative value of life is an important factor to consider when planning rehabilitation treatment in addition to preserving and extending life with respect to stroke, which is a chronic illness that negatively affects an individual's quality of life[15, 16]. Therefore, a creative rehabilitation program must be offered that considers mental aspects on top of medical treatment for improving a patient's balance and ability to walk when using exercise therapy for recovering functions in stroke patients.

Pilates training, which was developed by Joseph Pilates based on regulatory exercise training from spinal neutrality, was found to be highly effective for recovering physical functions such as improving sense of balance, flexibility, and muscle and cardiopulmonary functions in stroke patients in studies regarding the potential for Pilates training programs to be applied to patients who were neurologically diagnosed with chronic stroke[17, 18]. Further, Pilates training goes beyond physical development by using exercise methods or equipment and addresses all aspects of exercise that require mental control based on eight principles: control, breathing, flowing movement, precision, centering, stability, range of motion, and opposition, and improves an individual's health in terms of their mind and body and even their quality of life[16, 19, 20]. Pilates training also includes various programs that enable the participation of patients who cannot participate in normal exercises due to injury or vulnerable health issues through supportive equipment, such as Reformers, Cadillacs, Wunda Chairs, Magic Rings, Magic Circles, and various types of Foot Correctors, Sandbags, in addition to mat-based exercises[21]. Independent exercises can be created within each exercise process to match each individual's needs[22, 23]. Therefore, because Pilates is a type of supervised training, it can be an ideal method of exercise for stroke patients who are unable to exercise without help. It is a valuable rehabilitation exercise program that reduces secondary obstacles with respect to rehabilitation exercises for stroke patients, helps improve quality of life, and helps individuals exercise on their own with a sense of independence.

However, most studies on Pilates training programs are conducted based on orthopedic rehabilitation exercises[17, 24–26]. Based on studies on Pilates conducted on normal adults, consistent Pilates training resulted in increased abdominal strength, endurance, and trunk flexibility[27], increased endurance in the trunk extensor and flexor[28], and improved dynamic balance[29]. Studies conducted on senior citizens reported that Pilates was effective in improving static and dynamic balance[30, 31], and improving functions and strength in the lower extremities[32].

As such, the effects of Pilates training on physical functions have been verified in various age groups, particularly the elderly, but there are not yet any studies on the correlation between exercise in chronic stroke patients and quality of life. Therefore, this paper will conduct an in-depth survey on the influence of the Pilates training program on the quality of life in chronic stroke patients, and provide meaningful basic data that can be used for developing exercise programs that increase rehabilitative effects for stroke patients.

SUBJECTS AND METHODS

This study has 40 subjects (experimental group: n=20; control group: n=20). All were chronic stroke patients, and their general characteristics are provided in Table 1. The experimental group included 20 stroke patients from a rehabilitation center for the disabled. The control group included 20 stroke patients who were participating in general occupational therapy without any exercise-related activities. The selection criteria for the subjects in this study were as follows. 1) Patients with a disease duration of 1 year or longer, 2) Patients who scored 25 points or higher on the MMSE-K (Mini Mental State Examination-Korean), 3) Patients who are able to communicate, 4) Patients who did not faint or resist, 5) Patients who were able to walk for 10 min or longer. Patients with heart disease, high blood pressure, or pain that could not be controlled and patients with fractures in the pelvic floor, traumatic injury to the peripheral nerves, or visual or hearing disabilities were excluded. This study was approved by the Institutional Review Board of the Korea National Sport University (20161123–02), and conducted after the requirements and purpose of the study were thoroughly explained to all subjects and a written consent form was obtained.

The MMSE-K is a standardized cognitive function test that was developed by Folstein et al. [33], and then translated by Park and Kwon[34]. This test clinically evaluates cognitive level and was used in this study to evaluate the cognitive abilities that are required to participate in tasks when selecting research subjects. The MMSE-K has 12 items in six categories, and the reliability between inspectors is 0.9934. In the test results for each individual, scores of 24 of 30 or lower were evaluated as loss of perception, thus only patients with a score of 25 or higher and did not have loss of perception were selected as the research subjects.

The Korean Stroke Specific Quality of Life (SS-QOL) that was designed by Williams et al.[35] and adapted by Moon[36] was used as the evaluation tool to survey quality of life for the experimental group and control group. After the MMSE-K test, 40 subjects hoping to participate in this study personally completed and submitted a SS-QOL once before and after participating in the Pilates training program. The SS-QOL has 49 questions, including 11 questions regarding quality of life in the physical

Table 1 . General characteristics of research subjects

Group	EG	CG
Gender (M/F)	13/7	12/8
Average age (yrs)	63.5 ± 3.5	65.8 ± 4.2
Paralysis side (L/R)	10/8	10/8
Disease duration (months)	27.0 ± 4.55	29.0 ± 3.21
Cause of onset (cerebral hemorrhage/cerebral infarction)	10/10	12/8
MMSE-K score (M ± SD)	27.3 ± 0.45	27.4 ± 0.50

EG: Experimental group; CG: Control group. Values are expressed as group mean ± standard deviation.

domain, 22 questions regarding quality of life in the emotional domain, and 16 questions regarding quality of life in the social domain. Each item was measured on a Likert 5-point scale (1 point: strongly agree; 5 points: strongly disagree), and higher scores meant the individual reacted positively regarding their quality of life. The reliability of the SS-QOL has received positive reactions with a Cronbach's α value of 0.73 in the study conducted by Williams et al. and a Cronbach's α value of 0.80 in the study where it was translated into Korean.[36] It also showed a high relationship with the Bathel Index (BI), Beck Depression Inventory (BDI), Short Form (SF)-35, and MBI in comparative validity tests[35, 36].

This study applied a pre-test, post-test with control group design and had subjects from the experimental group participate in a 60-min Pilates training program twice a week for 12 weeks. The control group did not participate in any exercise-related activities for the duration of the experiment, and participated in a 50-min occupational session thrice a week.

The Pilates training program in this study lasted 60 min per session, involving 10-min warm-up exercises before the main exercises, 40-min main exercises, and 10-min cool-down exercises. Each action in the training was repeated eight times. The Pilates program used in this study was based on the actions used in the mat-based exercise program in a preceding study conducted by Lim et al.[37], and these actions were at beginning or intermediate levels, considering the characteristics of stroke patients. In addition, hemiplegia characteristics were put into consideration, and props were used to help subjects perform these actions. Props included balls, Magic Rings, and Thera-Bands. Considering that subjects were chronic stroke patients, Pilates mat exercises were modified to encourage subjects to perform them, and the exercises were performed by helping subjects modify and supplement each action[37].

SPSS for Window Version 21.0 was used to analyze the collected data, and all statistical significance levels were set to 0.05 for this study. When analyzing the study results, a Shapiro-Wilk normality test was conducted to check the normality of the quality of life between the experimental and control groups, and an independent sample t-test was conducted to test homogeneity before beginning the Pilates program. A matching sample t-test was conducted to compare the physical, social, and psychological domains of quality of life before and after starting the Pilates program for the experimental and control groups. Lastly, an independent sample t-test was conducted to compare the physical, social, and psychological domains of quality of life after starting the Pilates program for the experimental and control groups.

RESULTS

Before starting the program, the normality verification results for quality of life in the experimental group and control group showed that the significance probability for quality of life between the experimental (0.390) and control groups (0.055) was at least 0.05, which meant that all variables between the two groups had a normal distribution. Moreover, the comparison results regarding the homogeneity tests for the experimental and control groups showed that no significant difference ($p>0.05$) was found between the two groups regarding the physical, social, and psychological domains of quality of life and overall quality of life before participating in the Pilates training program as shown in Table 2. Therefore, the Pilates training program was conducted on the experimental group, assuming that the two groups were homogenous.

The results of comparing quality of life before and after participation in the Pilates training program for the experimental group and the control group showed a statistically significant difference ($p<0.05$) in the physical, social, and psychological domains of quality of life in the experimental group as shown in Table 3. However, no statistically significant difference was found in the control group ($p>0.05$). Furthermore, in the results of analyzing overall quality of life, a 0.35-point increase in score for the group that had participated in the Pilates program (experimental group) was observed, signifying a statistically significant increase in quality of life. However, a −0.02 point decrease in score for the control group compared with that before the program began, signifying that no statistically significant difference was found.

Ultimately, a 0.38-point increase in score in the social and psychological domains of quality of life and a 0.24 point increase in score in the physical domain of quality of life for the experimental group that participated in the Pilates training program were observed compared with that before they participated in the program. However, the only increase for the control group that did not participate in the Pilates training program was in the psychological domain of quality of life with a 0.03-point increase in score, and a decrease was observed in the physical and social domains.

Table 2. Homogeneity test on quality of life for the experimental and control groups

Domain	EG	CG
Physical	3.08 ± 0.54	2.98 ± 0.55
Social	2.70 ± 0.66	2.67 ± 0.50
Psychological	2.85 ± 0.42	2.81 ± 0.46
Total	2.88 ± 0.47	2.82 ± 0.38

EG: Experimental group; CG: Control group. Values are expressed as group mean ± standard deviation.

Table 3. Results of comparing quality of life by group according to their participation in the Pilates training program

Domain		Pre	Post
Physical	EG	3.08 ± 0.54	3.32 ± 0.64*
	CG	2.98 ± 0.55	2.92 ± 0.54
Social	EG	2.70 ± 0.66	3.08 ± 0.66*
	CG	2.67 ± 0.50	2.64 ± 0.54
Psychological	EG	2.85 ± 0.42	3.23 ± 0.64*
	CG	2.81 ± 0.46	2.84 ± 0.46
Total	EG	2.88 ± 0.47	3.23 ± 0.56*
	CG	2.82 ± 0.38	2.80 ± 0.38

EG: Experimental group; CG: Control group. Values are expressed as group mean ± standard deviation. *Significant difference between pre- and post-training ($p<0.05$)

Table 4. Comparison of quality of life between groups according to their participation in the Pilates training program

Domain	EG	CG
Physical	3.32 ± 0.64	2.92 ± 0.54*
Social	3.08 ± 0.66	2.64 ± 0.54*
Psychological	3.23 ± 0.64	2.84 ± 0.46*
Total	3.23 ± 0.56	2.80 ± 0.38*

EG: Experimental group; CG: Control group. Values are expressed as group mean ± standard deviation.
*Significant difference between pre- and post-training ($p<0.05$)

Unlike the results shown in Table 3 comparing the experimental and control groups, the results in Table 4 show that a statistically significant difference was found between the experimental and control groups ($p<0.05$) after participating in the Pilates training program. A statistically significant difference was found in all domains of quality of life, including the physical, social, and psychological domains for the quality experimental group that participated in the Pilates training program compared with the control group, and a statistically significant difference was also found in the overall quality of life.

In the analysis results, the score was 0.40 points in the physical domain of quality of life in the group that participated in the Pilates program (experimental group), 0.44 points in the social domain, 0.39 points in the psychological domain, for a total of 0.43 points.

DISCUSSION

This study observed changes in the quality of life of 40 chronic stroke patients who already completed hospitalization treatment after the onset of stroke by dividing them into the experimental (n=20) and control groups (n=20) and conducting a Pilates training program for 15 weeks. Here, the study results will be discussed.

A decrease in the ability to perform daily activities due to disabilities resulting from a stroke reduces an individual's independent lifestyle and also decreases quality of life[8–10]. Therefore, an effective rehabilitation program for stroke patients must not only restore their physical functions, but also help with stability and support in consideration of their quality of life[38–40]. Hence, the Pilates training program that is used as the intervention method in this study was an aerobic exercise at a low intensity that is appropriate for the elderly, unlike high-intensity muscle exercises. It is a remarkably effective intervention method that can help restore physical functions and increase desire to participate, similar to other rehabilitation exercise programs without need for fear of resistance training in subjects[16, 41–43].

Various studies have reported that Pilates training exhibits positive effects, such as core strength and flexibility in the elderly[19, 23, 44, 45], muscle endurance[23, 24], posture improvement[44], dynamic balance[16, 19, 29, 41, 46] etc. Based on these preceding studies, Pilates is recognized as an exercise program that is effective in restoring physical functions in stroke patients[18]. For elderly females, Pilates training was shown to improve autonomy, static balance, and quality of life[16], and even improve quality of life that had decreased due to chronic disorders over a long period[20, 47, 48].

As such, Pilates training is being used as a positive exercise program that can improve quality of life, including physical rehabilitation, but there is a lack of preceding studies on whether or not Pilates training programs can bring changes in the quality of life in stroke patients. Hence, statistically significant improvement ($p<0.05$) in the physical, social, and psychological domains of quality of life through participation in Pilates by stroke patients as shown in the results of this study can be used as basic data that can propose Pilates training as an extremely effective exercise method for improving quality of life in addition to restoring functions in stroke patients. Although the discussion has many limitations due to a lack of preceding studies regarding quality of life in stroke patients, the study results are in line with the results of studies that examined quality of life in the elderly or disabled individuals who participated in Pilates training, including some studies reporting that quality

of life in the elderly increased as the level of participation in Pilates increased[20, 21, 42] and another study by Choi[49] reporting that quality of life increased with respect to joy, sense of satisfaction, and sense of happiness in disabled individuals through regular Pilates training.

Pilates training not only improves physical function in stroke patients with reduced independence as shown in preceding studies, but it is also an extremely effective exercise program that improves quality of life in stroke patients as shown in the current study results. This study only compared between an experimental group that participated in Pilates training and a control group, but follow-up studies must verify the effect between Pilates training and other intervention methods to improve quality of life. There is also a need to observe changes in quality of life by applying this study on acute or subacute stroke patients or other patients with varying neurological disorders instead of chronic stroke patients. Finally, there is also a need to observe changes in quality of life through participation in autonomous exercises considering restrictions in time and space when participating in the Pilates training program.

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REFERENCES

1) Sims NR, Muyderman H: Mitochondria, oxidative metabolism and cell death in stroke. Biochim Biophys Acta, 2010, 1802: 80–91. [Medline] [CrossRef]
2) Johnson W, Onuma O, Owolabi M, et al.: Stroke: a global response is needed. Bull World Health Organ, 2016, 94: 634–634A. [Medline] [CrossRef]
3) de Vries S, Mulder T: Motor imagery and stroke rehabilitation: a critical discussion. J Rehabil Med, 2007, 39: 5–13. [Medline] [CrossRef]
4) Haghgoo HA, Pazuki ES, Hosseini AS, et al.: Depression, activities of daily living and quality of life in patients with stroke. J Neurol Sci, 2013, 328: 87–91. [Medline] [CrossRef]
5) Herman T, Giladi N, Gruendlinger L, et al.: Six weeks of intensive treadmill training improves gait and quality of life in patients with Parkinson's disease: a pilot study. Arch Phys Med Rehabil, 2007, 88: 1154–1158. [Medline] [CrossRef]
6) Chung EJ, Lee BH: A comparison of balance, activities of daily living and quality of life in stroke patients with depression and those without depression. Kor J Exerc Rehabil, 2012, 8: 61–69.
7) Nelson R: Robotics augments stroke rehabilitation. Eval Eng, 2017, 56: 28.
8) Niemi ML, Laaksonen R, Kotila M, et al.: Quality of life 4 years after stroke. Stroke, 1988, 19: 1101–1107. [Medline] [CrossRef]
9) Patel MD, Tilling K, Lawrence E, et al.: Relationships between long-term stroke disability, handicap and health-related quality of life. Age Ageing, 2006, 35: 273–279. [Medline] [CrossRef]
10) Yelnik A, Bradaï N: [Rehabilitation after ischemic stroke in the elderly]. Psychol Neuropsychiatr Vieil, 2005, 3: 157–162 (in French). [Medline]
11) Aström M, Asplund K, Aström T: Psychosocial function and life satisfaction after stroke. Stroke, 1992, 23: 527–531. [Medline] [CrossRef]
12) Tang A, Sibley KM, Thomas SG, et al.: Maximal exercise test results in subacute stroke. Arch Phys Med Rehabil, 2006, 87: 1100–1105. [Medline] [CrossRef]
13) Pollock C, Eng J, Garland S: Clinical measurement of walking balance in people post stroke: a systematic review. Clin Rehabil, 2011, 25: 693–708. [Medline] [CrossRef]
14) Tyson SF, Hanley M, Chillala J, et al.: The relationship between balance, disability, and recovery after stroke: predictive validity of the Brunel Balance Assessment. Neurorehabil Neural Repair, 2007, 21: 341–346. [Medline] [CrossRef]
15) Garland SJ, Ivanova TD, Mochizuki G: Recovery of standing balance and health-related quality of life after mild or moderately severe stroke. Arch Phys Med Rehabil, 2007, 88: 218–227. [Medline] [CrossRef]
16) Siqueira Rodrigues BG, Ali Cader S, Bento Torres NV, et al.: Pilates method in personal autonomy, static balance and quality of life of elderly females. J Bodyw Mov Ther, 2010, 14: 195–202. [Medline] [CrossRef]
17) Critchley DJ, Pierson Z, Battersby G: Effect of pilates mat exercises and conventional exercise programmes on transversus abdominis and obliquus internus abdominis activity: pilot randomised trial. Man Ther, 2011, 16: 183–189. [Medline] [CrossRef]
18) Shea S, Moriello G: Feasibility and outcomes of a classical Pilates program on lower extremity strength, posture, balance, gait, and quality of life in someone with impairments due to a stroke. J Bodyw Mov Ther, 2014, 18: 332–360. [Medline] [CrossRef]
19) Cruz-Ferreira A, Fernandes J, Laranjo L, et al.: A systematic review of the effects of pilates method of exercise in healthy people. Arch Phys Med Rehabil, 2011, 92: 2071–2081. [Medline] [CrossRef]
20) Kim E: Effect of Pilates on the improvement of quality of life and blood inflammatory makers in patient with Crohn's disease. Doctoral Dissertation. Hanyang University Seoul South Korea, 2015.
21) Kravitz K, Shedden M: Pilates exercise: a research-based review. J Dance Med Sci, 2006, 10: 111–117.
22) Power Pilates: Comprehensive manual. New York: Power Pilates, 2006.
23) Rogers K, Gibson AL: Eight-week traditional mat Pilates training-program effects on adult fitness characteristics. Res Q Exerc Sport, 2009, 80: 569–574. [Medline] [CrossRef]
24) Lim C, Chen Y, Lim H, et al.: A retrospective evaluation of isotonic strengthening with clinical pilates exercises on patients with chronic low back pain. Physiotherapist Singap, 2008, 11: 5–12.

25) Posadzki P, Lizis P, Hagner-Derengowska M: Pilates for low back pain: a systematic review. Complement Ther Clin Pract, 2011, 17: 85–89. [Medline] [CrossRef]
26) Rydeard R, Leger A, Smith D: Pilates-based therapeutic exercise: effect on subjects with nonspecific chronic low back pain and functional disability: a randomized controlled trial. J Orthop Sports Phys Ther, 2006, 36: 472–484. [Medline] [CrossRef]
27) Sekendiz B, Altun O, Korkusuz F, et al.: Effects of Pilates exercise on trunk strength, endurance and flexibility in sedentary adult females. J Bodyw Mov Ther, 2007, 11: 318–326. [CrossRef]
28) Donahoe-Fillmore B, Hanahan N, Mescher M, et al.: The effects of a home Pilates program on muscle performance and posture in healthy females: a pilot study. J Womens Health Phys Therap, 2007, 31: 6–11. [CrossRef]
29) Johnson EG, Larsen A, Ozawa H, et al.: The effects of Pilates-based exercise on dynamic balance in healthy adults. J Bodyw Mov Ther, 2007, 11: 238–242. [CrossRef]
30) Bird ML, Hill KD, Fell JW: A randomized controlled study investigating static and dynamic balance in older adults after training with Pilates. Arch Phys Med Rehabil, 2012, 93: 43–49. [Medline] [CrossRef]
31) Hyun J, Hwangbo K, Lee CW: The effects of pilates mat exercise on the balance ability of elderly females. J Phys Ther Sci, 2014, 26: 291–293. [Medline] [CrossRef]
32) Bird ML, Fell J: Positive long-term effects of Pilates exercise on the aged-related decline in balance and strength in older, community-dwelling men and women. J Aging Phys Act, 2014, 22: 342–347. [Medline] [CrossRef]
33) Folstein MF, Folstein SE, McHugh PR: "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res, 1975, 12: 189–198. [Medline] [CrossRef]
34) Park J, Kwon Y: Standardization of Korean version of the Mini-Mental State Examination (MMSE-K) for use in the elderly. J Korean Neuropsychiatr Assoc, 1989, 28: 508–513.
35) Williams LS, Weinberger M, Harris LE, et al.: Development of a stroke-specific quality of life scale. Stroke, 1999, 30: 1362–1369. [Medline] [CrossRef]
36) Moon J: A study on the factors affecting stroke quality of life: using the stroke-specific quality of life (SS-QOL). Master Thesis. Daegu University South Korea, 2003.
37) Lim HS, Kim YL, Lee SM: The effects of Pilates exercise training on static and dynamic balance in chronic stroke patients: a randomized controlled trial. J Phys Ther Sci, 2016, 28: 1819–1824. [Medline] [CrossRef]
38) Clarke P, Black SE: Quality of life following stroke: negotiating disability, identity, and resources. J Appl Gerontol, 2005, 24: 319–336. [CrossRef]
39) King RB: Quality of life after stroke. Stroke, 1996, 27: 1467–1472. [Medline] [CrossRef]
40) Mackay-Lyons MJ, Makrides L: Longitudinal changes in exercise capacity after stroke. Arch Phys Med Rehabil, 2004, 85: 1608–1612. [Medline] [CrossRef]
41) Irez GB, Ozdemir RA, Evin R, et al.: Integrating pilates exercise into an exercise program for 65+ year-old women to reduce falls. J Sports Sci Med, 2011, 10: 105–111. [Medline]
42) Newell D, Shead V, Sloane L: Changes in gait and balance parameters in elderly subjects attending an 8-week supervised Pilates programme. J Bodyw Mov Ther, 2012, 16: 549–554. [Medline] [CrossRef]
43) Weiss A, Suzuki T, Bean J, et al.: High intensity strength training improves strength and functional performance after stroke. Am J Phys Med Rehabil, 2000, 79: 369–376, quiz 391–394. [Medline] [CrossRef]
44) Emery K, De Serres SJ, McMillan A, et al.: The effects of a Pilates training program on arm-trunk posture and movement. Clin Biomech (Bristol, Avon), 2010, 25: 124–130. [Medline] [CrossRef]
45) Kloubec JA: Pilates for improvement of muscle endurance, flexibility, balance, and posture. J Strength Cond Res, 2010, 24: 661–667. [Medline] [CrossRef]
46) Lim HS: Effect of pilates exercise on balance and cardiopulmonary function in chronic stroke patients. Doctoral Dissertation, Sahmyook University Seoul South Korea, 2015.
47) Cohen RD: The quality of life in patients with Crohn's disease. Aliment Pharmacol Ther, 2002, 16: 1603–1609. [Medline] [CrossRef]
48) Narula N, Fedorak RN: Exercise and inflammatory bowel disease. Can J Gastroenterol, 2008, 22: 497–504. [Medline] [CrossRef]
49) Choi J: A causal relation between pilates participation of adult and physical and psychological factors change, and psychological well-being. Doctoral Dissertation, Wonkwang University South Korea, 2009.