



# Effect of Tai Chi Chuan on degeneration of lumbar vertebrae and lumbar discs in middle-aged and aged people: a cross-sectional study based on magnetic resonance images

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Chenghu Deng<sup>1</sup> and Wei Xia<sup>2</sup>

## Abstract

**Objective:** Exercise has a positive effect on physical fitness. Tai Chi Chuan is a traditional Chinese aerobic exercise. We assessed the effect of Tai Chi on the degeneration of lumbar vertebrae and lumbar discs with magnetic resonance images.

**Methods:** This retrospective cohort study involved 2 groups of participants: 27 Tai Chi practitioners with more than 4 years of experience with regular Tai Chi exercise and 24 sex- and age-matched participants without Tai Chi experience. The lumbar magnetic resonance images of all participants were collected. The numbers of degenerated lumbar vertebrae and lumbar discs were evaluated by the same radiologist, who was blind to the grouping.

**Results:** The Tai Chi practitioners had significantly fewer degenerated lumbar vertebrae (1.9) and lumbar discs (2.3) than the control group (2.6 and 2.9, respectively). The most severely affected lumbar vertebrae and discs were L5 and L4/L5, respectively.

**Conclusion:** Regular performance of the simplified Tai Chi 24 form could possibly retard the degeneration of lumbar vertebrae and lumbar discs in middle-aged and aged people.

## Keywords

Tai Chi, magnetic resonance imaging, lumbar vertebrae, lumbar disc, middle-aged people, aged people

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<sup>2</sup>Department of Medical Imaging, Hubei Maternal and Children's Hospital, Wuhan, Hubei, China

### Corresponding author:

Wei Xia, Department of Radiology, Hubei Maternal and Children's Hospital, Wuluolu 745, Hongshan District, Wuhan 430070, China.

Email: 176778380@qq.com

<sup>1</sup>Department of Physical Education, Wuhan University of Technology, Wuhan, Hubei, China



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## Introduction

Health has become an important topic for the general public because of the growing elderly population and rising medical expenses. Lumbar disorders are costly; the total cost exceeds 100 billion dollars per year in the United States.<sup>1,2</sup> As a traditional Chinese aerobic exercise, Tai Chi has been proven effective for many age-related diseases, especially cardiovascular disease<sup>3-8</sup> and metabolic syndrome,<sup>9</sup> because it can lower the blood pressure and control indicators of metabolic syndrome. However, little information is available regarding the relationship between Tai Chi and lumbar degenerative disease despite most aged people having some degree of lumbar degeneration.<sup>2</sup> Various studies have revealed the positive effects of exercise on the musculoskeletal system.<sup>10</sup> Tomaszewski et al.<sup>11</sup> used Tai Chi exercises as a novel supplementation to a comprehensive rehabilitation program. Harada<sup>12</sup> regarded Tai Chi as effective for joint pain and stiffness and found that it could improve symptoms of osteoarthritis. Physical exercises are considered protective factors for the lumbar spine.<sup>13,14</sup> A finite element study showed that the disc pressure changed more significantly in flexion than in extension or axial rotation; the same study also confirmed that pressure was reduced at multiple levels while in extension postures.<sup>15</sup> Magnetic resonance (MR) images have the advantages of multiple planes, multiple parameters, high resolution, and a large field of view; therefore, we chose this imaging technique as the standard with which to evaluate degeneration of the lumbar vertebrae.

The present study included 27 Tai Chi practitioners and 24 participants without Tai Chi experience. The MR images of their lumbar spine were studied to determine the number of degenerated lumbar vertebrae and discs.

## Materials and methods

This study was performed in our university. Because the simplified Tai Chi 24 form is the simplest form of Tai Chi and was created for the purpose of Tai Chi popularization, it was chosen for the training course in our university Tai Chi clubhouse as well as the present study. All 50- to 70-year-old members of the Tai Chi clubhouse were invited to join the study. All had been members of the clubhouse for at least 4 years. Professional trainers in Tai Chi were invited by the clubhouse to serve as teachers and supervisors. All of the practitioners attempted to follow the standard gesture without experiencing pain. Tai Chi training was performed in this clubhouse every day for 1 hour in the morning (6:30–7:30 a.m.), including a 20-minute warm-up involving stretching exercises, performance of the simplified Tai Chi 24 form five times, and a 10-minute relaxation exercise. All practitioners were free of uncontrolled hypertension (blood pressure of  $\geq 180/100$  mmHg), lumbar malformation, and active symptomatic joint disease.

The control participants were other staff members from the same university and were selected among faculty members who participated in a health examination (age of 50–70 years). The control participants matched the Tai Chi practitioners in sex, age, weight, height, and body mass index (BMI). They had no experience with regular Tai Chi or other exercise. The control participants were also free of uncontrolled hypertension, lumbar malformation, and active symptomatic disease.

The protocol for this study was approved by the ethics committee of the hospital where the MR imaging had been performed, and written informed consent was obtained from all participants.

Data on the sex, age, weight, height, and BMI of all participants were retrieved

**Table 1.** Characteristics of Tai Chi practitioners and controls

	Tai Chi practitioners (n = 27)	Controls (n = 24)	p value
Sex	16 male 11 female	13 male 11 female	0.134
Age (years)	60.6 ± 2.8	61.3 ± 2.8	0.348
Weight (kg)	66.9 ± 6.5	67.1 ± 8.3	0.924
Height (cm)	168.7 ± 6.9	167.3 ± 7.4	0.508
Body mass index (kg/m <sup>2</sup> )	23.5 ± 0.8	23.9 ± 1.1	0.152

Data are presented as average ± 1 standard deviation.

(Table 1). All participants' lumbar vertebral MR images, which are a part of the physical examination at the university, were collected for the most recent year. All MR imaging findings were assessed by the same qualified radiologist who was blinded to the grouping. Lumbar vertebrae with degeneration (osteoporosis, hyperosteo- eny) and lumbar discs with degeneration (low signal intensity, herniation) were defined as degenerated (Figure 1). Because all participants were free of active symptomatic disease, no lumbar instability was observed. The numbers of degenerated lumbar vertebrae and discs in all participants were recorded. The results from the Tai Chi practitioners and controls were compared using the chi-square test for sex and the independent-samples t-test for the remaining variables.

## Results

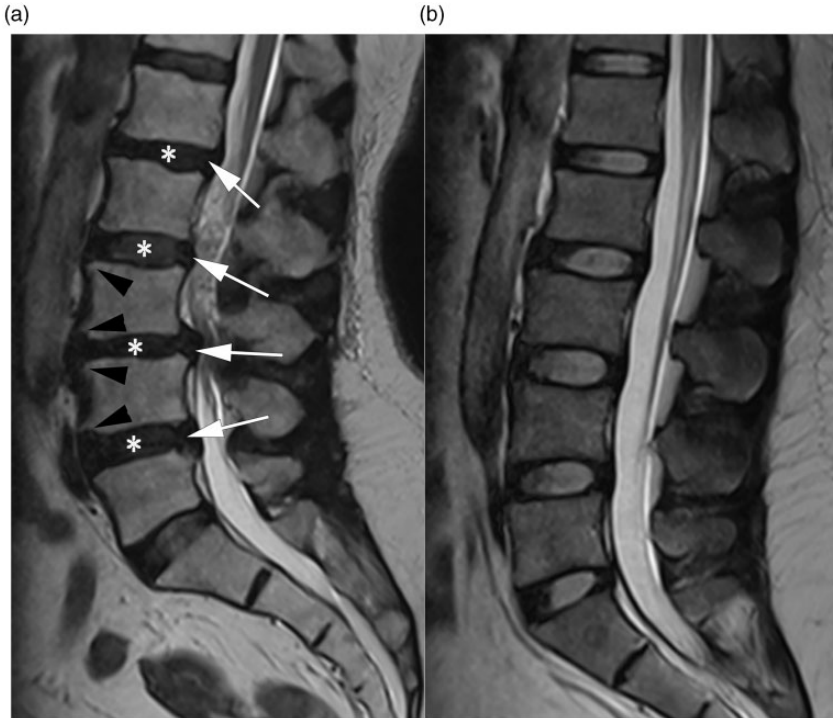
This study included 27 Tai Chi practitioners and 24 control participants (selected from among 57 faculty members). The average age, weight, and BMI of the controls was higher than that of the Tai Chi practitioners, while the average height of the practitioners was higher than that of the controls. However, there were no statistically significant differences in the sex, age weight,

height, or BMI between the Tai Chi practitioners and controls (Table 1).

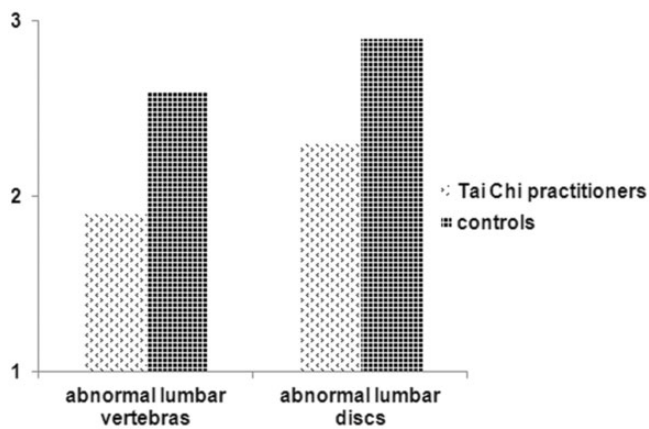
The numbers of degenerated lumbar vertebrae and lumbar discs were determined through MR imaging by the qualified radiologist. Assessment included identification of any degenerative conditions such as lumbar disc herniation, lumbar disc degeneration, and lumbar vertebral hyperosteo- eny. An image of a normal lumbar vertebra of a 65-year-old female Tai Chi practitioner is compared with a lumbar vertebra of a control participant in Figure 1.

The numbers of degenerated vertebrae in Tai Chi practitioners and controls were 52 and 62, respectively, while the numbers of degenerated discs in Tai Chi practitioners and controls were 61 and 69, respectively. The most severely affected vertebra was L5 (Tai Chi group, n = 22; control group, n = 24), and the most severely affected disc was L4/L5 (Tai Chi group, n = 24; control group, n = 24).

Figure 2 shows the significant differences in the average number of degenerated lumbar vertebrae and lumbar discs between the Tai Chi practitioners and controls ( $p < 0.01$ ). The average numbers of degenerated lumbar vertebrae and lumbar discs were lower in the Tai Chi practitioners than controls ( $1.9 \pm 0.7$  versus  $2.6 \pm 0.8$  and  $2.3 \pm 0.8$  versus  $2.9 \pm 0.7$ , respectively).



**Figure 1.** Median sagittal T2-weighted image of a lumbar vertebra. (a) Lumbar disc herniation (arrow), lumbar disc degeneration (asterisk), and lumbar vertebral hyperosteogeny (arrowhead) of a female participant in the control group. (b) Median sagittal T2-weighted image of a normal vertebra of a female Tai Chi practitioner.



**Figure 2.** Average differences in degenerated lumbar vertebrae and discs between Tai Chi practitioners and controls ( $p < 0.01$ ).

## Discussion

The present study is the first to evaluate the degenerative condition of the lumbar vertebrae and lumbar discs associated with Tai Chi training by MR imaging. The findings of this study revealed significantly fewer degenerated lumbar vertebrae and lumbar discs in Tai Chi practitioners who had been regularly practicing the simplified Tai Chi 24 form for more than 4 years than in sex- and age-matched controls.

These findings regarding the lumbar vertebrae may be partially explained by retardation of age-related bone loss in Tai Chi practitioners, which could be observed directly on MR images, as reported in several previous studies.<sup>16-22</sup> However, nearly all of these previous studies were focused on the bone density in postmenopausal women, while our study directly revealed degenerated lumbar vertebral changes not only in women but also in middle-aged and aged men.

To the best of our knowledge, no previous studies have assessed the differences in lumbar discs between Tai Chi practitioners and control participants without Tai Chi experience. Although regular exercise has been confirmed to be beneficial for patients with lumbar disc herniation,<sup>23-26</sup> resistance exercises may cause an adverse metabolic response.<sup>27</sup> Tai Chi is a gentle, rhythmic exercise with muscle strengthening elements, including in the lumbar region.<sup>28</sup> This type of exercise is considered suitable for older individuals because of its higher safety and convenience than other moderately intense exercises such as cycling, stair climbing, and jogging.<sup>29</sup> Degenerative changes of the intervertebral discs, which involve cell-mediated immune responses and physical and biologic mechanisms, can be clearly delineated on MR images.<sup>30,31</sup> Singh et al.<sup>32</sup> reported that the decline in the lumbar extensor muscle strength in older adults was dependent on age. Our finding of fewer degenerated

lumbar discs in Tai Chi practitioners than controls may be associated with the muscle strengthening elements of Tai Chi, especially the extensive gentle stretching, as confirmed in the finite element study by Kuo et al.<sup>15</sup> Additionally, the most severely affected disc in the present study (L4/L5) is in accordance with that in the study by Kuo et al.<sup>15</sup> Another study indicated that strong and flexible lumbar muscles could provide effective support for the lumbar spine, maintain the normal lumbar curvature, and avoid overexercise.<sup>33</sup> A normal curvature refers to appropriate pressure on the lumbar discs, which is related to retardation of lumbar disc degeneration. This is beneficial not only for the lumbar discs but also for the lumbar vertebrae.

Compared with a prospective randomized study, our retrospective cohort study has some inherent limitations, including the lack of programmed Tai Chi intervention of a specifically designed intensity, frequency, and duration; the lack of a standard protocol for MR imaging; the lack of previous MR images for comparison; a small sample size; and lack of before-and-after comparison of Tai Chi exercise. Although the controls were matched to the Tai Chi group in terms of sex, age, weight, height, and BMI, some potential confounding effects may have still been present because of the small sample size. Additionally, future studies should consider the Tai Chi practitioners' actual adherence to practice during the 4 years, their history of physical sports activities, and the participants' professional work, medication, prior injuries, lumbar curvature, and other factors. Because all participants were drawn from a university, our results may be influenced by selection bias. The function of the lumbar muscles should be taken into consideration when evaluating the lumbar spine. Moreover, the obtained data would be more persuasive if Tai Chi is compared with another moderate-intensity exercise

such as jogging, cycling, or stair climbing. Novel technology should be applied to the evaluation of lumbar spine imaging, such as diffusion-weighted MR imaging.<sup>34</sup>

## Conclusion

This study has revealed general retardation of degeneration of the lumbar vertebrae and lumbar discs in Tai Chi practitioners through MR imaging. These findings may imply positive effects of regular Tai Chi exercise on the function of the lumbar spine and should be further investigated in future studies. Further studies should be designed to discover the effects of Tai Chi exercise in preventing lumbar disorders of middle-aged and aged people and improving their life quality.

## Declaration of conflicting interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

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