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Higher DHEAS Levels Associated with Long-Term Practicing of Tai Chi

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Abstract

Tai Chi has many benefits for middle-aged/older individuals including improvements to muscle strength and various body lipid components. DHEAS and testosterone have anti-obesity/anti-aging characteristics and also improve libido, vitality and immunity levels. Thus, the aim of the present study was to investigate the differences between middle-aged Tai Chi practitioners (n = 17) and sedentary individuals (n = 17) in terms of leg strength, blood levels of cholesterol, triglyceride, HDL, as well as DHEAS, testosterone and cortisol. Unpaired *t*-tests were used to identify significant differences between the two groups. There were no significant differences in body composition, leg strength, blood lipid components and testosterone. However, the Tai Chi practitioners had higher levels of DHEAS ($P < 0.01$) and lower levels of cortisol ($P < 0.05$). Thus, Tai Chi practitioners have a higher ratio of DHEAS to cortisol, which might have potential benefits in terms of improving an individual's health-related quality of life during the aging.

Key Words: aged, cortisol, exercise, meditation, quality of life, sex steroids

Introduction

Dehydroepiandrosterone (DHEA) and its sulphated metabolite, dehydroepiandrosterone sulphate (DHEAS) are the most plentiful sex steroids in the circulation in man, and they are also precursors of testosterone (7). DHEAS is 300 to 500 times higher in serum concentrations than DHEA and is less affected by the human diurnal rhythm. Therefore, the concentration of DHEAS is often chosen as the stand approach to measuring DHEA levels clinically. DHEA and DHEAS production peaks between 20 and 30 years old and are thought to have anti-obesity and anti-aging effects, as well as the ability to improve libido and vitality (13). Moreover, DHEA and DHEAS do decline progressively as an individual ages and this may impair the quality of life of older men. This decline in DHEAS may also influence the levels of testosterone. Lower levels of testosterone have been shown to have a strong association with lipid metabolism, namely lower testosterone is linked to an increase in serum cholesterol and triglycerides, together with a decrease in high-density lipoprotein (HDL) (19). In addition, many harmful impacts that stress has on health have been well documented. Such

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impacts occur with stress-induced hyper-reactivity of the hypothalamus-pituitary-adrenal axis, thus increasing the production of cortisol (5). Constantly elevated level of cortisol has an immunosuppressive effect (2). Higher level of cortisol is associated with increased inflammation and the development of cardiovascular disease (12).

Previous studies show that increase in DHEA and DHEAS in response to exercise is age depending. Similar results with DHEA and DHEAS have been observed with long-term exercises (13). Acute exercise can increase levels of testosterone (11). However, long-term resistance exercise is required to enhance basal levels of testosterone. Compared to long-term resistance exercise, long-term aerobic exercise increases testosterone levels with smaller increments (9, 10).

Tai Chi is a traditional conditioning exercise that is based on Chinese martial arts and philosophy. Groups of Chinese have practiced Tai Chi exercise in the early morning since the 12th century and continue to do so in large numbers. Tai Chi exercise is a moderate intensity exercise and was believed in ancient China to be better adapted to people who are middle-aged or older (15). The characteristics of Tai Chi exercise consists of breathing exercises that are matched to slow meditative and graceful movements that simulate the postures of various animals in nature. Thus one can enjoy practicing Tai Chi from an integrated perspective that leadings to universal harmony; it allows practitioners to resets themselves with the aim of reaching an ultimate inner calmness (21). Therefore, after Tai Chi practice, one feels free and refreshed both in body, mind and spirit, and have the energy to start a new day that may have the need for fight or flight (3). Importantly, the practice of Tai Chi is reported to affect the basal activity of the hypothalamus-pituitary-adrenal axis and decrease the levels of cortisol of its practitioners (14, 21).

Tai Chi exercise has been shown to activate the parasympathetic nervous system, as well as reducing the level of activity of the sympathetic nervous system; such changes may be effective at bringing about improvements in diseases of the elderly that involve the autonomic nervous system (20). Therefore, practicing Tai Chi as an exercise has been reported to improve health-related quality of life. Yet, until now, only a few reports have investigates the effects of Tai Chi on body composition, blood lipid components and male sex steroids.

As mention above, exercise would seem to be able to increase levels of DHEA and DHEAS, as well as testosterone. However, most studies have focused on aerobic exercise or resistance exercise. Tai Chi has drawn a lot of attention because it is easy to learn, cheap to do and is able to be performed anywhere. In fact Tai Chi is known already to improve lower body strength and balance (27). Nevertheless, little research has been carried out on investigating whether Tai Chi exercise affects the levels of male sex steroids and various other lipid components present in individuals. Therefore, the aim of the present study was to compare the differences in basal levels of DHEAS, testosterone, cortisol, triglyceride, cholesterol and HDL, as well as muscle strength, between long-term Tai Chi practitioners and matched sedentary individuals.

Materials and Methods

Participants

The participants who formed the Tai Chi group were recruited from the Taipei New Generation CMC Tai Chi Chuan Association of Taipei City. All of the participants had at least four or more years of Tai Chi experience, which they undertook more than three times per week for 40 min per session. The sedentary control group were recruited from the Datong District of Taipei City. They had not participated in any regular exercise for at least one year. By self-report, all participants were without any history of cardiovascular disease, did not smoke, did not drink alcohol and were not taking any type of medicine. This study and the consent form were approved by the Human Subject Committee of the National Taiwan Sport University (etd-0702108-151557). All participants gave written informed consent.

Procedure

After a 10-h overnight fast and 48-h of abstention from strenuous activity, the body composition of the two groups of subjects was measured and then blood samples were obtained from a forearm vein; these events took place in the morning between 08:00 and 10:00. After 24-h of rest, lower body strength was measured.

Body Composition

The body composition of the subjects was measured by bioelectrical impedance assessment (InBody 3.0, Biospace, Korea). Body mass index (BMI) was calculated by dividing the body in kilograms by the square of height in meters.

Blood Samples and Biochemical Analyses

The whole blood was centrifuged at 3000 *g* for 10 min at 10°C and the resulting serum was divided into a number of aliquots and immediately stored frozen at -80°C. Serum triglyceride, cholesterol and HDL concentrations were measured using a Beckman CX-7 spectrophotometer analyzer using enzymatic colori-

Table 1 Mean values ± SD of physical characteristics

	Control (n = 17)	Tai Chi (n = 17)	*P*-values
Age (years)	52.94 ± 3.92	53.84 ± 5.35	0.58
Height (cm)	169.35 ± 4.36	169.06 ± 6.91	0.88
Body mass (kg)	74.65 ± 10.56	70.93 ± 9.65	0.29
Body fat (%)	29.63 ± 7.48	29.01 ± 6.08	0.80
BMI (kg/m^2)	25.57 ± 3.24	24.93 ± 3.03	0.55
Leg strength (kg)	69.29 ± 20.52	83.68 ± 27.29	0.14

Note. BMI = body mass index

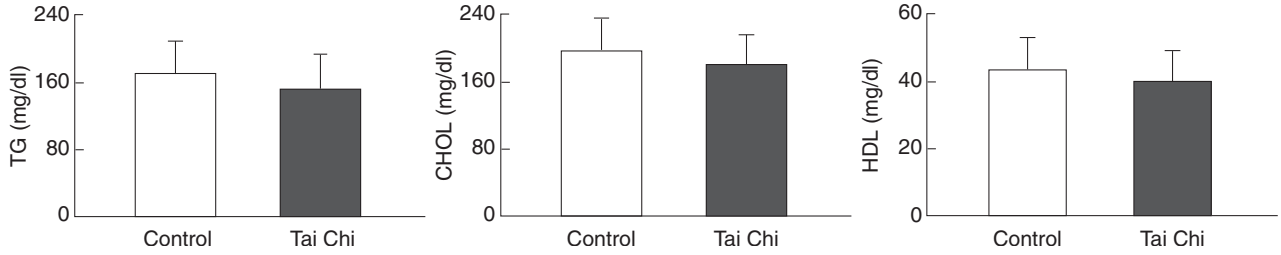

Fig. 1. Basal levels of serum triglyceride (TG), serum cholesterol (CHOL) and serum high-density lipoprotein (HDL) of the sedentary control and Tai Chi groups. Each value represents means ± SD (n = 17).

metric methods (Wako, Osaka, Japan) according to the manufacturer's procedure. The concentrations of serum DHEAS, serum total testosterone (TT) and serum free testosterone (FT) were measured with enzyme-linked immunosorbent assay (ELISA) analyzer (Tecan Genios, Salzburg, Austria).

Leg Strength

Isometric leg strength was measured using a strength dynamometer (TKK5402, Takey, Tokyo, Japan). Participants were asked to stand upright on the base of the dynamometer with feet a shoulder-width apart. The arms were allowed to hang straight down and the center of the bar was then grasped with both hands. Next the chain was adjusted such that the knees were bent at approximately 110 degrees. The individual was then asked to pull against the weight steadily with maximum isometric effort while keeping their feet flat on the base of the dynamometer. When this external force is applied to this dynamometer, the score represents the maximum static force produced by leg strength.

Statistical Analysis

Unpaired *t*-tests were carried out to identify significant differences between the two study groups for all variables. A level of $P < 0.05$ was set for significance for all tests. Data are presented as means ± standard deviation (SD).

Results

The Physical Characteristics and Leg Strength

Thirty-four volunteers male, aged 50-65 years old, were eligible under our study's criteria. These consisted of seventeen Tai Chi practitioners who formed the Tai Chi group and seventeen healthy individuals who formed the sedentary control group. The physical characteristics of the participants with respect to age, height, body mass, body fat and BMI of the two group are shown in Table 1. As can be seen, there are no significant differences between the sedentary control and Tai Chi group for these variables. Furthermore, there are also no differences in leg strength between the two groups of participants (Table 1).

The Basal Level of the Lipid Components

The lipid components of participants, namely the basal levels of triglyceride, cholesterol and HDL from sedentary control and Tai Chi group were also determined and again no differences were found between two groups for these factors (Fig. 1).

The Basal Levels of Cortisol

The basal levels of cortisol was significantly lower

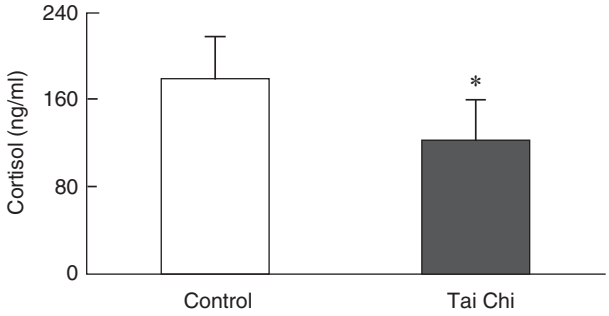

Fig. 2. Basal levels of cortisol of the sedentary control and Tai Chi groups. *$P < 0.05$ compared with the sedentary control group. Each value represents means ± SD (n = 17).

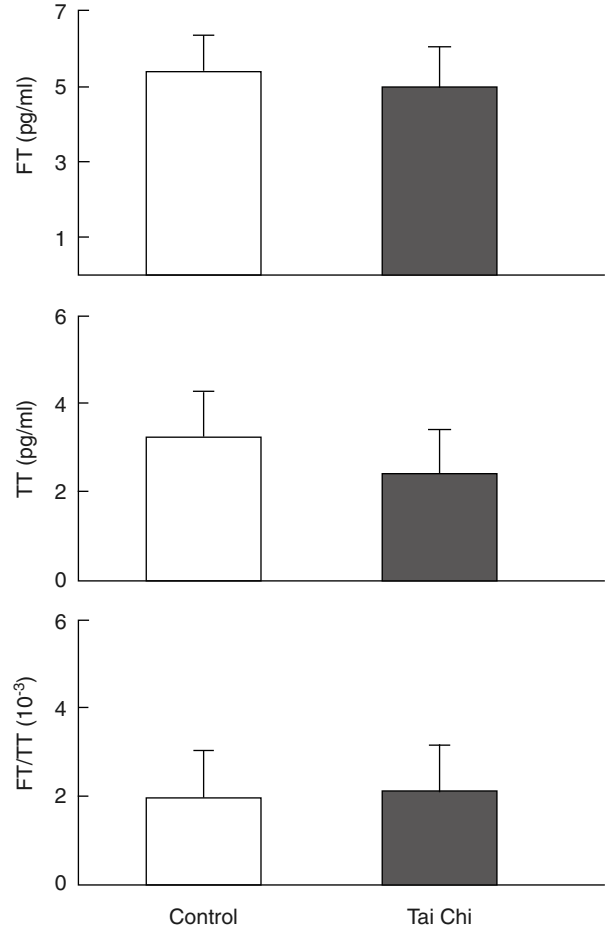

Fig. 3. Basal levels of serum free testosterone (FT), serum total testosterone (TT), and the FT to TT ratio of the sedentary control and Tai Chi groups. Each value represents means ± SD (n = 17).

in Tai Chi group compared with sedentary control ($P < 0.05$) (Fig. 2).

The Basal Levels of Testosterone

The basal levels of total testosterone, free testosterone and ratio of free testosterone to total testosterone of the sedentary control and Tai Chi group are presented in Fig. 3. There were no differences between the two groups for these factors.

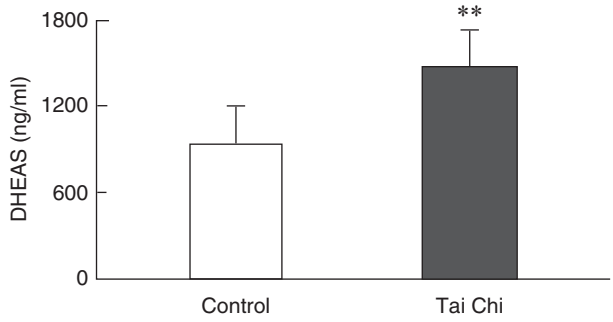

Fig. 4. Basal levels of serum dehydroepiandrosterone sulfate (DHEAS) of the sedentary control and Tai Chi groups. **$P < 0.01$ compared with the sedentary control group. Each value represents means ± SD (n = 17).

The Basal Levels of DHEAS

The basal levels of DHEAS was significantly higher in Tai Chi group compared with sedentary control ($P < 0.01$) (Fig. 4).

The Ratios of DHEAS to Cortisol, Free Testosterone and Total Testosterone

The ratio of DHEAS to cortisol was significantly higher in Tai Chi group compared with sedentary control ($P < 0.01$). However, the ratio of DHEAS to free testosterone did not show a significant difference between these two groups. Finally, in contrast to the above, the ratio of DHEAS to total testosterone, there was significantly higher in Tai Chi group compared with sedentary control ($P < 0.01$) (Fig. 5).

Discussion

There were no differences between the sedentary control group and the Tai Chi group when physical characteristics and a number of different lipid blood components were compared and similar results have been observed among the healthy elderly participants after Tai Chi training for a year (30). When the leg strength of the two groups of participants was investigated, it was also found that there was no difference between the control and Tai Chi groups; nevertheless it has been shown that Tai Chi exercise training does improve leg strength and balance among older adults who are over 70 years old (27). The muscle cross-sectional area of the thigh decreases by about 40% between the ages of 20 years and 60 years. In addition, healthy subjects lose muscle mass in com-

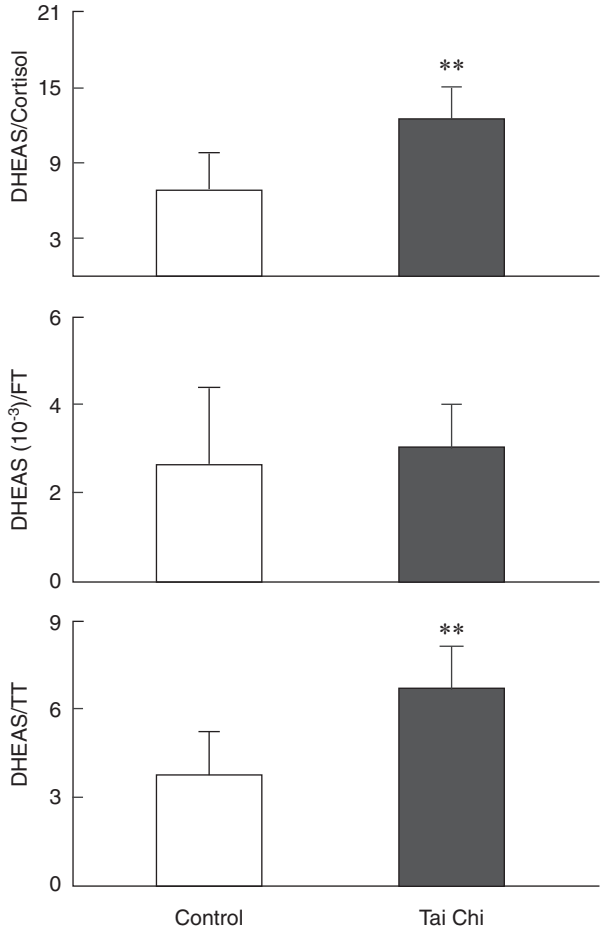

Fig. 5. The ratios of dehydroepiandrosterone sulfate (DHEAS) to cortisol, free testosterone (FT) and the total testosterone (TT) of the sedentary control and Tai Chi groups. $^{**}P < 0.01$ compared with the sedentary control group. Each value represents means ± SD (n = 17).

bination with a 1.5% annual decline in strength after age of 35 years and this phenomena accelerates to around 3% per year when he person is aged over 60 years (18). Therefore, the benefit to muscle strength of Tai Chi may depend on the age of the participants. The differences between the present findings and those of earlier studies may be explained in two ways. Firstly, the age profile of the study participants in the present study ranges from 50 years to 65 years and this is quite different to the age profiles of the groups in previous studies. Secondly, the number of participants in each of the two study groups is relatively low and this could easily have had an effect on the statistical resolving power of the study.

Nevertheless, Tai Chi exercise was found to decrease the level of cortisol in participant group. This decrease seems to be related to retaining a healthy psychological and physiological state, which among the Tai Chi participants would help individuals to withstand the harmful impact of stress (14, 21). The mindfulness meditation during Tai Chi exercise might also enhance immune functions, diminish the reactivity of the autonomic nervous system and increase telomerase activity, as well as longevity (22). Since stress is able to increase an individual's level of cortisol within 15 min (16), the decrease in cortisol level brought about by Tai Chi exercise might save energy by improving instinctive determination when fight-or-flight is needed (6).

There were no differences in the basal levels of total testosterone and of free testosterone among the participants. Testosterone levels have been shown to increase among elderly patients with benign prostate hypertrophy after Tai Chi training for a year (15). In the present study, nevertheless, Tai Chi exercise training did not affect the basal level of testosterone among our healthy participants. As mentioned above, acute exercise is able to increase the level of testosterone, which is an important factor in relation to improve muscle mass and strength (26). However, long-term exercise training has been found not sufficient to have a persistent impact on the basal level of testosterone (17) and these findings agree with our results concerning the basal levels of testosterone among Tai Chi participants. Nevertheless, the level of testosterone present in blood immediately after Tai Chi exercise does need further investigation.

Interestingly, the Tai Chi group did have higher basal levels of DHEAS. To our knowledge this is the first study to investigate the long-term effect of Tai Chi on the DHEAS levels of practitioners. DHEAS production begins to decline after puberty such that it can be reduced to 20% to 30% of its original levels among the elderly. This is due to a progressive atrophy of the zona reticularis of the adrenal glands (7, 8). This lowering of DHEAS levels is related to the aging process and is associated with the various functional declines that affect the immune system. Furthermore, it is well known that the level of cortisol remain remarkably unaltered by the aging process, which resulted in an imbalance between the two hormones (2). A lower ratio of DHEAS to cortisol would seem to increase the risk of immune impairment and infection (24). It has been suggested that DHEA is positively correlated in male individuals with antibacterial activity against salivary bacteria and an attenuation of cortisol-induced neutrophil suppression (2, 25). This is the first study to find that Tai Chi exercise brings about an enhancement of the ratio of DHEAS to cortisol. In present study, Tai Chi participants have significant higher ratio of DHEA to total testosterone not to free testosterone. However, the ratio of DHEAS to testosterone is reported negatively correlated to prostate volume (23). Moreover, Tai Chi training in patients with innocuous prostate hypertrophy is able to improve lower urinary tract symptoms as well as qual-

ity of life (15).

Well-being encompasses not only the physical body but also the spiritual, mental and emotional parts of an individual's life. Tai Chi has integrative powers that affect mind-body-spirit connections. For example, Tai Chi has been characterized as a method that focuses on the interactions between the brain, the nervous system, the mind, the endocrine glands and behavior, with the intent of using such mind-body connections to promote health (28). Therefore, the ancient Chinese mind-body-spirit exercise of Tai Chi may provide an alternative and self-sustaining option when coping with the stress and anxiety associated with a fast-paced metropolitan life without any requirement for specialized gymnasium equipment. At the same time, Tai Chi exercise training has been reported to reduce cortisol levels in healthy individuals as well as cancer survivors (4, 29). It is also interesting to note that Tai Chi practitioners exhibit lower cortisol levels and a reduced heart rate when subjected to a psychosocial stress test (1). Therefore, Tai Chi is likely to help practitioners to take problems/difficulties in their stride and allow them to solve such events calmly and more easily at the right moment.

In conclusion, although long-term Tai Chi exercise did not affect a range of lipid basal components, leg strength or testosterone levels among middle-aged men, it did, importantly, increased the ratio of DHEAS to cortisol. In addition, the moderate exercise intensity of Tai Chi is known to reduce the risk of injury among middle or older individuals. Therefore, practicing Tai Chi as an exercise could be a good choice if an individual wants to improve the their quality of life as aging begins to cast it effects.

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