



## Self-assessment of health condition and its association with the risk of fracture of Tai Chi practitioners

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*Authors' Contribution: A – Study Design, B – Data Collection, C – Statistical Analysis, D – Manuscript Preparation, E – Funds Collection*

### Abstract

**Introduction:** The positive impact of Tai Chi on body balance and coordination has been confirmed in many intervention and prevention programs for elderly people, especially in the field of falls and fractures. The aim of the study was to determine the impact of a six-month Tai Chi program on self-assessment of health condition of practitioners aged 50 years and older. The relationship between this variable and 10-year fracture risk was also evaluated. **Material and Methods:** The study involved 41 persons aged 50 and more (mean 61.5, SD=6.1) - beginning tai chi practice. Self-assessment of health condition was performed using a 5-point scale, while a 10-year fracture risk was estimated using both the FRAX calculator and the GARVAN nomogram (on-line versions). Self-assessment of health condition was conducted during the first and sixth month of Tai Chi classes. The fracture risk was assessed at the beginning of the training program. **Results:** There was a statistically significant improvement in self-assessment of health condition after 6 months of tai chi practice both in the whole study group ( $p=0.0023$ ) and in the subgroup of women ( $p=0.0005$ ). Perceived improvement was independent of age. There was also a correlation between better self-assessment of health condition measured before Tai Chi program and lower 10-year fracture risk calculated from GARVAN nomogram ( $p=0.0146$ ). Greater improvement in self-assessment of health conditions a result of Tai Chi program was reported for participants with lower 10-year fracture risk estimated by GARVAN nomogram ( $p=0.0642$ ). **Conclusions:** Health benefits from participating in the 6-month Tai Chi program have occurred in community-dwelling elderly people regardless of their age. Due to the different algorithms used in the FRAX and GARVAN tools and different definition of the term "osteoporotic fracture", it is not possible to directly compare the results obtained with these two methods.

**Keywords:** Tai Chi, elderly people, fracture risk, self-assessment, health condition

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Received: 30.01.2018; Accepted: 1.06.2018; Published online: 4.07.2018

**Cite this article as:** Milert A, Klich W, Ridan T. Self-assessment of health condition and its association with the risk of fracture of Tai Chi practitioners. *Physical Activity Review* 2018; 6: 127-135. doi: 10.16926/par.2018.06.17

## INTRODUCTION

Aging, although is a normal biological process, clearly increases the risk of age-related diseases and disability. The factors such as: life style, nutrition, physical activity, stress exposure, social engagement, cognitive stimulation etc. have a significant influence on the quality of aging [1,2] Their accurate assessment is required to evaluate the current state as well as to design most effective intervention. For that purpose both subjective (self-reported) and objective measures are recommended.

Improving or maintaining the quality of life of older people at their optimal level is in the interest of specialists in the field of medical, social and economic sciences. However, despite an increasing interest on the improvement of the quality of life in elderly there is no generally accepted definition of "successful aging" [3,4]. As such, there is no standard way to achieve the successful aging strategy [5]. Therefore many methods can be used to improve the quality of life of older people, depending on their personal needs. Hence, multifactorial interventions appear to be more effective for individuals with functional loss and disability. Several studies indicate that those are the main aspects of health that people take into account in their self- ratings [6]. Self-reported activity limitation is one of the main functional problems faced by older people every day. With age, there is a change in spatio-temporal gait parameters related to gait speed and medial-lateral control of the hip [7]. Balance impairment and the chronic diseases makes the older adults more susceptible to falls [8].

Falls are associated with greater functional decline, social withdraw, anxiety and depression [9,10]. They also lead to another consequence of falling associated with decreased mobility - fear of falling [11]. The falls of older individuals frequently result in injury and/or disability. The most serious consequence of falling of older people are fractures. According to WHO about 30% of community-dwelling people aged 65 years and over fall at least once every year and almost 10-15% of falls result in fracture [12-15]. For this reason, identification of people at high risk of fracture is of great importance. Currently, fracture risk calculators are commonly used for this purpose, the most popular ones being FRAX (recommended by the WHO) and the GARVAN nomogram. Both of these tools are available online [16,17]

There is now strong evidence that the physical exercises are most effective in the prevention of falls of community-dwelling older people [18]. It is recommended that such exercise should provide moderate or high challenge to balance training, be undertaken at least 2 hours a week and preferably in a group or home-based setting. They should also target both the general community and those at high risk for falls [19]. Group-based Tai Chi exercises are proved to be a good example of physical activity following above recommendations.

Tai Chi (TC) is a form of Chinese Martial Art which over the years became popular form of exercise throughout the world and has drawn increasing research interest [20]. Nowadays TC is focused on body environment and mind and body integration rather than fighting. This movement approach has been used as an exercise form and has evolved into slow, relaxed, smooth, and graceful movements [21]. Tai Chi use for preventive health and health maintenance is complex intervention. Like other eastern movement therapies, e.g. yoga and qigong, it incorporates a mind-body approach. Tai Chi practice include relaxation and extension of the body with an awareness of trunk alignment [22]. Today TC is practiced primarily by older people, both in the prevention and treatment of many chronic medical conditions. A growing body of clinical research confirms the efficacy of TC as a therapy for poor postural balance, decreased muscle strength and flexibility, increased fall risk and fear of falling [23-27].

Regular Tai Chi practicing can be beneficial for physical, mental and social aspects of health. Therefore the purpose of the present study was to determine whether 6-months of supervised group Tai Chi exercises promote better self-assessment of health condition among community-dwelling elderly people. Additionally, we examined the relationship between self-assessed general health and the risk of osteoporotic fracture calculated using two calculators available on-line: FRAX and GARVAN.

## MATERIAL AND METHODS

### *Participants*

The study was conducted among 41 students of the Tai Chi Chuan School in Krakow, Poland, who in 2015-2016 started learning Chen style Tai Chi and participated in classes at least for six months. Inclusion criteria were: age over 50 years, no medical conditions excluding from participating in exercises, attendance of at least 85% of Tai Chi classes and written consent to participate in research. The first stage of research involved 62 individuals who met the age requirement and were willing to participate. After 6 months of training 9 participants did not take part in the second stage of research and 12 students did not meet the criterion of attendance. Finally, the study group consisted of 41 persons: 32 women and 9 men. The age mean in the group was 61 years and body mass index (BMI) (kilograms per meter squared) was 24.73. Baseline characteristics for age and BMI of men and women are shown in table 1.

### *Tai Chi Program*

Tai Chi classes were conducted in groups of 6-10 students by instructors with a minimum of 5 years' experience. All classes lasted 90 minutes, took place twice a week in the afternoon and were carried out in the 1st degree course of Chen Style.

Each training began with the warm-up (20 min) and consisted of stretching, relaxation, breathing and concentrating exercises. The main part of the training (60 minutes) in the first weeks included focused on learning how to feel, distinguish and control the state of tension and relaxation in the body as well as to build a proper body structure. At first the participants learned four forms of Can Si Gong (exercises typical of Chen Style), in order to understand the basics of conducting Qi energy. Attention was paid to the neutral alignment of the spine and the symmetrical loading of the right and left leg. Gradually the smooth shifting of the body weight from foot to foot in a proportion of 25% - 75% was introduced. While learning to take steps in various directions (forwards, backwards, sideways, turning around, lunges forward and sideward), particular attention was paid to the practitioners' safety.

Then, steps were combined with the movements of the upper limbs, in order to improve balance and coordination. The main principles of the Tai Chi were introduced stepwise, based on 13-movement form created by Master Chen Bing as introduction to Chen Style Taijiquan. This form was chosen because is simple, short and all the movements come from Laojia frame.

### *Methods*

The assessment of the influence of the 6-month Tai Chi training on self-assessed general health (SAH) was based on the answer given to the question: "In general, how would you rate your health?" [28]. The answers were evaluated on a five-point grading scale: 1 - very poor, 2 - poor, 3 - moderate, 4 - good, 5 - very good. SAH assessment was carried out at the beginning and end of the six-month period of participation in Tai Chi classes. 10-yr fracture risk was estimated using both the FRAX calculator and the GARVAN nomogram (on-line versions). The fracture risk was assessed at the beginning of the training program. None of the persons participating in the study had a Bone Mineral Density (BMD) measurement. The following data was used to assess the fracture risk with the GARVAN nomogram: age, sex, weight, fractures since the age of 50 (excluding major trauma, e.g. car accidents) and falls over last 12 months [16]. When calculating the fracture risk with the FRAX, the following variables were taken into account: age, sex, weight, height, and risk factors such as: previous fracture (i.e. in adult life occurring spontaneously, or a fracture arising from trauma which, in a healthy individual, would not have resulted in a fracture) parent fractured hip, current smoking, glucocorticoids, rheumatoid arthritis, secondary osteoporosis, alcohol 3 or more units/day [17].

The assessment of the osteoporotic fracture risk was carried out at the beginning of the Tai Chi training. During the 6 months of the training none of the participants reported additional risk factors for osteoporotic fracture included in FRAX or GARVAN algorithms.

Table 1. Tai chi group - baseline characteristics

	n	%	Mean	SD	min	max
<b>Age</b>						
Men	9	21.95	62.78	4.73	54	68
Women	32	78.05	61.09	6.44	50	75
Total	41	100.00	61.46	6.15	50	75
<b>BMI</b>						
Men	9	21.95	24.41	2.81	20.76	31.14
Women	32	78.05	24.82	4.03	19.53	35.80
Total	41	100.00	24.73	3.80	19.53	35.80

SD - standard deviation

### Statistics

For the purpose of statistical analysis the mean values and standard deviations of the examined variables were determined. Spearman correlation coefficients were used to quantify the relationship between age and SAH before and after Tai Chi exercises as well as SAH and fracture risk. Chi-square test was used to assess SAH improvement as a result of exercise. The level of significance for all statistical tests was set at 0.05. Calculations were performed using the statistical package Statistica V10.0.

## RESULTS

The first stage of the analysis was the assessment of the SAH level in the study group before and after the 6-month Tai Chi training. None of the respondents from the first and second study described their health status as: "very poor" or "poor". There was a statistically significant improvement in SAH in the whole group ( $p=0.0023$ ) and for women ( $p=0.0005$ ). For men the improvement was not statistically significant ( $p=0.6374$ ). Detailed results are presented in table 2.

The next stage of the analysis was the assessment of the relationship between the age of the respondents and the SAH results at the beginning of Tai Chi exercise as well as the change in SAH after 6 months of exercise. The results indicate that the age is not related to SAH level. There is also no relationship between the change in SAH as a result of participation in the Tai Chi program and age (Table 3).

The 10-year osteoporotic fracture risk based on the FRAX and GARVAN calculators was assessed among the participants of Tai Chi program. Since none of the subjects had risk factors for osteoporotic fracture listed in the calculators and none of the them had BMD measurements, the fracture risk was calculated based on the following variables: age, sex, body weight (FRAX, GARVAN) and body height (FRAX).

Table 2. Level of self-assessed general health (SAH) of the studied group pre and post 6-months Tai Chi training

	pts	SAH	Pre-training		Post-training	
			N	%	N	%
Men	3	moderate	-	-	-	-
	4	good	5	56	4	44
	5	very good	4	44	5	56
Women	3	moderate	6	19	2	6
	4	good	25	78	16	50
	5	very good	1	3	14	44
Total	3	moderate	6	15	2	5
	4	good	30	73	20	49
	5	very good	5	12	19	46

Table 3. Correlation between age and SAH and SAH improvement in the tai chi group

AGE	Men [n=9]		Women [n=32]		Total [n=41]	
	R	p	R	p	R	p
SAH	0.1310	0.7369	-0.0046	0.9801	0.0828	0.6068
SAH change	-0.0452	0.9081	0.0177	0.9236	-0.0290	0.8572

R - Spearman rank correlation, p - statistical significance

Baseline characteristic for the 10-year fracture risk for hip and 10-year osteoporotic fracture risk calculated using the FRAX and the GARVAN tool in the study group are presented in Tables 4 and 5. There is a significant difference between the two methods when estimating the risk of osteoporotic fracture especially among women. 10 year Hip Fracture Risk calculated for women using the FRAX tool is 3 times higher than estimated using the GARVAN nomogram. For the entire group the risk of hip fracture counted by the FRAX tool is twice as high as calculated using the GARVAN nomogram. The reverse is the situation for 10 year Osteoporotic Fracture Risk. The risk estimated for women and for the entire study group using the GARVAN nomogram is 3 times higher than using the FRAX calculator.

The next stage of the analysis was the assessment of the relationship between SAH and the 10 year risk of osteoporotic fracture and hip fracture estimated using the FRAX and GARVAN algorithms. The change in SAH as a result of the participation in 6-month Tai Chi program in relation to the estimated risk of fracture was also assessed. The results are shown in Tables 6-9.

There was a statistically significant relationship between better self-esteem of health before the beginning of Tai Chi exercise and a lower 10-year risk of osteoporotic fracture calculated using the GARVAN nomogram ( $p = 0.0146$ ) and the FRAX tool ( $p = 0.0536$ ) in the entire group. This relationship was not observed separately in the group of women and men nor in the case of a 10-year risk of hip fracture. The risk of osteoporotic fracture and hip fracture calculated using the FRAX algorithm and the GARVAN nomogram did not show any relationship with change in HAS as a result of 6 months of Tai Chi exercise.

Table 4. FRAX and GARVAN - baseline characteristics for 10 year Hip Fracture Risk [%]

	n	%	Mean	SD	min	max
<b>FRAX</b>						
Men	9	21.95	0.50	0.25	0.2	2.0
Women	32	78.05	0.82	0.50	0.2	2.1
Total	41	100.00	0.75	0.47	0.2	2.1
<b>GARVAN</b>						
Men	9	21.95	0.83	0.51	0.2	2.0
Women	32	78.05	0.28	0.16	0.1	0.8
Total	41	100.00	0.40	0.36	0.1	2.0

SD - standard deviation

Table 5. FRAX and GARVAN - baseline characteristics for 10 year Major Osteoporotic Fracture Risk (FRAX) and 10 year Any Osteoporotic/Fragility Fracture Risk (GARVAN) [%]

	n	%	Mean	SD	min	max
<b>FRAX</b>						
Men	9	21.95	2.18	0.33	1.7	2.9
Women	32	78.05	3.63	1.10	2.2	6.4
Total	41	100.00	3.31	1.15	1.7	6.4
<b>GARVAN</b>						
Men	9	21.95	2.78	1.13	1.0	4.0
Women	32	78.05	10.78	3.28	6.0	18.0
Total	41	100.00	9.02	4.43	1.0	18.0

SD - standard deviation

Table 6. Correlation between SAH and 10-year Major Osteoporotic Fracture Risk calculated by FRAX in the tai chi group

FRAX - OP	Men [n=9]		Woman [n=32]		Total [n=41]	
	R	p	R	p	R	p
SAH	0.2620	0.4959	-0.0184	0.9205	-0.3036	<b>0.0536</b>
SAH change	-0.3164	0.4068	0.1409	0.4419	0.2581	0.1033

R - Spearman rank correlation, p - statistical significance

Table 7. Correlation between SAH and 10 year Hip Fracture Risk calculated by FRAX in the tai chi group

FRAX - HIP	Men [n=9]		Woman [n=32]		Total [n=41]	
	R	p	R	p	R	p
SAH	0.3508	0.3546	0.0240	0.8962	-0.0543	0.7361
SAH change	-0.2774	0.4699	0.1426	0.4364	0.1426	0.3737

R - Spearman rank correlation, p - statistical significance

Table 8. Correlation between SAH and 10 year Any Osteoporotic/Fragility Fracture Risk calculated by GARVAN in the tai chi group

GARVAN - OP	Men [n=9]		Woman [n=32]		Total [n=41]	
	R	p	R	p	R	p
SAH	0.2251	0.5603	-0.0920	0.6165	-0.3788	<b>0.0146</b>
SAH change	-0.1657	0.6701	0.1508	0.4099	0.2918	0.0642

R - Spearman rank correlation, p - statistical significance

Table 9. Correlation between SAH and 10 year Hip Fracture Risk calculated by GARVAN in the tai chi group

GARVAN- HIP	Men [n=9]		Woman [n=32]		Total [n=41]	
	R	p	R	p	R	p
SAH	0.0442	0.9101	-0.1232	0.5016	-0.2077	0.1925
SAH change	0.0356	0.9275	0.1561	0.3936	-0.0512	0.7504

R - Spearman rank correlation, p - statistical significance

## DISCUSSION

The assessment of the self-reported general health in subjects over 50 years of age was carried out using simple question: "In general, how would you rate your health?". This is one of the most common questions used to assess SAH in social sciences. Previous research has shown its high correlation with socioeconomic status, retirement, physical functioning and psychosocial factors [28].

The popularity of this question stems from its generality. The concept of health is very complex, hence it is understood in different ways. Therefore the subjective assessment is a resultant of the psychophysical and mental state of the subject. With regard to the specificity of Tai Chi exercises, the above question asked about self-assessment of health is particularly useful, because it covers all above mentioned fields of health. Regular Tai Chi practice influence the physical health by strengthening the muscles, improving range of motion, balance and coordination. Tai Chi as a group exercises enables contact with other people with similar interests. Tai Chi performed in a smooth and gentle way helps in gaining self-awareness and better control emotions. That is why Tai Chi is often called "mind-body" exercises or "meditation in motion" [20,29]

The beneficial, multidirectional influence of this form of activity on physical and psychosocial well-being of the elderly has been confirmed in many research papers [30-31] Our study shows a significant improvement in SAH after 6 months of regular practice. We assume that the improvement achieved was not only influenced by the physical training, but also by the pleasant atmosphere in the classroom and the age diversity in the exercise group - the persons participating in the study exercised together with the younger people what could be encouraging and motivating (psychosocial effect).

The results of our study indicate significant difference in SAH between women and men. Men assessed their health only on the level of "good" and "very good", while 19% of the surveyed women described their health status as "moderate". After 6 months of exercise this rating increased significantly, remaining on "moderate" level only in 6% of the examined women.

Above gender differences in self-reported health, i.e. women generally have poorer self-reported health than men, are observed in many research papers [32]. No correlation between age and SAH and SAH improvement in the Tai Chi group may indicate that observed positive effects of 6-months tai chi practice are not related to age and this form of exercise can be beneficial for both younger and older practitioners.

10-year fracture risk was calculated using FRAX Calculator and GARVAN Nomogram. These methods were chosen because in algorithms estimating fracture probability bone mineral density (BMD) measurement is optional [33-34]. Both tools are available on-line and have 10 year hip fracture risk and 10 year osteoporotic fracture risk and they are the most popular.

However, both tools vary from each in many significant aspects. They use different number of risk factors (FRAX 11 vs GARVAN 5, excluding BMD). In FRAX algorithm the fall risk is not incorporated, though most fractures results from falls [35]. It is therefore suggested, that FRAX score should be the first choice in daily practice for patients with no history of recurrent falls, and GARVAN might be more appropriate for patients who have already had falls [36]. Another important difference between FRAX and GARVAN is that each tool defines "osteoporotic fracture" differently, which complicates direct comparison between this two methods. Also, only FRAX has been calibrated to the epidemiology of fracture in Poland. Above mentioned main differences between both tools may be the explanation for such a discrepancy on osteoporotic fracture risk, especially among women.

Despite the differences between GARVAN and FRAX, the osteoporotic fracture risk calculated using both methods indicate the lower SAH of participants with higher fracture risk. This relationship, however, remains unclear. It is possible, that since SAH is a multidimensional concept [37] the variables such as co-morbidities other than fracture risk factors may influence lower self-rated health status. Further studies are needed to define this relationship.

Our study has several limitations: (1) it was not designed specifically to determine whether self-assessment of health condition among community-dwelling elderly people practicing Tai Chi is associated with the risk of fracture, (2) the sample size was relatively small, (3) the Tai Chi classes were conducted in 3 different rooms, and (4) none of participants had had previous BMD measurement, diagnosed osteoporosis or osteoporotic fracture.

## CONCLUSION

Health benefits from participating in the 6-month Tai Chi program have occurred in community-dwelling elderly people regardless of their age. Due to the different algorithms used in the FRAX and GARVAN tools and different definition of the term "osteoporotic fracture", it is not possible to directly compare the results obtained with these two methods.

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