

Tai-Chi Exercise Training and its Promising Therapeutic Impacts among Older Community Dwelling Adults with Painful Knee Osteoarthritis

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Abstract

Knee joint osteoarthritis, a chronic condition resulting in considerable disability, particularly in later life, not only impacts life quality significantly and severely, but is also strongly associated with the persistence of intractable pain, depression, helplessness, and a high falls injury risk. This narrative overview synthesizes the knowledge base regarding painful knee osteoarthritis and what is known about Tai Chi exercise participation in the context of reducing knee joint disability and its associated risk of one or more injurious falls, as well as pain and depression. To this end, all relevant articles published in the English language on the topic were sought. While most reports rely on Eastern observations, rather than Western medicine studies, collectively, these data reveal that Tai Chi practiced widely in Asia for many centuries may have an enormous positive impact on reducing distress and increasing function and autonomy among older adults living in the community and diagnosed as having knee osteoarthritis. They specifically suggest the increasing numbers of older adults diagnosed as having knee osteoarthritis can safely practice selected Tai Chi exercises with the expectation that consistent applications will enhance mobility, reduce pain and depression, plus instability and possible injurious falls, while reducing fatigue, even if surgery is forthcoming.

Introduction

Knee joint osteoarthritis is a widespread highly disabling chronic destructive health condition affecting one or both knees. Prevalent among the older adult population, the disease commonly progresses slowly and often spreads to include other joints and physical as well as neurological and cognitive body systems adversely. Consistently associated with the localized breakdown of key joint structures such as its force sensitive cartilage lining, plus its adjacent bone, the disease induces varying degrees of intractable pain, knee joint stiffness and swelling as well as deficits or damage to affected surrounding joint structures, such as muscle that is not readily amenable to repair or remediation [1, 2].

However, unlike most other chronic health condition that can be treated quite successfully and identified early on, osteoarthritis damage is often asymptomatic and hard to diagnose until its destruction is structurally or symptomatically evident. Moreover, since its origins remain in question, treatments are often not targeted at all specifically, and tend to be generally palliative with some degree of risk and no evidence of any permanent respite or reversal of the damage to the joint at this point in time—even if confirmed using advanced technologies and artificial intelligence.

At the same time, mounting evidence points to a projected exponential rise in osteoarthritis cases by 2050 as society ages and caring for the older adult in the presence of knee joint osteoarthritis may be especially problematic in those with chronic pain, plus those who are either obese or frail. In addition, in the case of any age associated tendency to fall, the affected older adult with knee osteoarthritis who wishes to reside independently in the community may be placing themselves at risk for injury and further debility, even if they have had knee replacement surgery or are healthy.

However, this health condition is often prevalent in those with heart and metabolic diseases who may not be able to exercise in a traditional manner, or attend therapies in the community, thus are at increased risk for sedentary behaviors, rather than the pursuit of functional activities of daily living and self care. They may consequently incur a state of obesity or frailty and with this structural worsening of the already compromised joint[s]. Since joint health depends in part on intermittent exposure to physiological levels of joint compression and decompression, as well as the supportive quality of surrounding muscles and ligaments, the sedentary older adult may indeed suffer an excess loss of joint structural tissues needed for function and shock-absorption and incite a repetitive cascade of inflammatory responses to joint damage [3]. Moreover, as the disease progresses, and adults in severe pain are forced to utilize more medications than not, they may become further impaired if they fall due to cognitive interactions that interfere with desired timely and carefully modulated motor reflexes and a lower ability to enact joint protection against damaging molecular mechanisms of the disease [4, 5]. Affected older adults who use non prescribed or multiple medications incautiously may also fall more readily and repeatedly especially if their cognitions are impaired and endurance is limited [6].

On the other hand, even though it may be possible to repair a damaged joint successfully in the future, the success of this effort may yet require attention to the ongoing need for joint protection and reflexive neural mechanisms such as those that can be carefully developed through long term exercises. That is, whether or not targeted reparative efforts or joint replacement surgery or both are forthcoming, exercises such as those that foster muscle strength, balance and functional abilities may prove paramount in protecting the joint from impact, while lessening pain and falls injury risks at all disease stages.

Moreover, those that can also reduce anxiety, depression, sleep challenges, obesity, joint instability, and fatigue, and do not involve undue stress on the affected joint[s], and can be done in the home with low impact and intensity independent of an instructor, may prove highly valuable.

Unfortunately, despite the aforementioned challenges associated with knee osteoarthritis among the older population, plus decades of related research, there is as yet, no effective safe pharmacologic remedy to limit or eliminate the key biological changes as well as these interacting oftentimes progressive symptoms and signs of this condition. In addition, its excess falls risk could prove devastating in its own right [7]. Moreover, some medications may not only be injurious to joint tissues and others, but may inadvertently damage cartilage, while increasing the risk for falling. Yet, exercises or interventions that can reduce the need for pain medication and foster better mood states and sleep quality, as well as joint stability, such as Tai Chi appear to offer highly promising preventive and remediable results. In addition to helping restore function and ameliorate pain in severe cases of the disease, surgery may be more successful via efforts to build up the patient's postural and muscle strength capacity.

As well, in addition to clinical and experimental evidence to suggest that by removing some or the key causes of any prevailing impaired cartilage cell biology- more advanced analyses tentatively show direct impacts or interactions of various modes of Tai Chi on bone, muscle coordination, and muscle atrophy in pathological knee joints and others. As such it appears multiple clinically oriented health benefits are likely to emerge in response to the practice of Tai Chi, regardless of mode of Tai Chi employed in older adults with osteoarthritis, Tai Chi is said to enable the normal healing and repair processes needed to foster function [3]. Tai Chi participation and practice can also be expected to improve cardio-respiratory function as well as exercise endurance among people with arthritis [8], while assisting in weight reduction [9]. Additionally, along with improvements in health perceptions, joint flexibility and muscle power [10], participation in regular Tai Chi exercise may decrease the severity of anxiety and depression found among people with knee osteoarthritis [11].

However, when even the shortest exercise bout may cause pain and leave the osteoarthritis patient with more, rather than less pain, and many adults with osteoarthritis also suffer from obesity, joint inflammation, and poor bone health, exercises that may overexert this patient group or cause undue fatigue, as well as injurious impacts on their already damaged joints is something patients as well as their practitioners may want to actively avoid. As well, certain exercises that increase the risk of injuries such as falls, fatigue, pain, and poor balance issues, need to be avoided at all costs.

On the other hand, exercises that are gentle, as well as those that mimic normal daily movements, and that can currently be done indoors, as well as outdoors, with no equipment and independently of a gym or trainer, if required, would appear highly warranted as well as helpful and relevant in the context of the older adult who wants to reside in the community. Moreover, those exercises that can simultaneously allay anxiety and depression, those that can help to offset obesity, and that can improve life quality and functional capacity are especially advocated. While many forms of exercise exist, this current paper focuses on examining the results of representative studies that discuss the efficacy of Tai Chi - a mind-body light to moderate intensity exercise approach, especially practical and useful for seniors [12]. In particular, it examines its observed benefits for ameliorating falls in older knee osteoarthritis cases. The value of this therapeutic mode of intervention for fostering over all life quality is also highlighted.

Tai Chi was specifically chosen in this respect because it can be carried out in multiple venues at low cost and with a high safety record. Moreover, most reports indicate this form of exercise to be a helpful form of therapy for mature adults facing multiple health problems and where fear and distress are commonplace. Widely practiced in China for many centuries as an art or self-defense form, Tai Chi, a category of the broader QiGong health approach can be undertaken by people of all ages as a preventative and restorative form of therapy with a strong ability to improve balance; promote postural

stability, aerobic capacity [3]; decrease falls [13], reduce pain, and stress.

Methodology

To establish whether the application of Tai Chi can be recommended for older adults with knee osteoarthritis, data for this strictly narrative topic overview were downloaded from those available on the PUBMED, GOOGLE SCHOLAR, and PUBMED CENTRAL electronic data sources that house valid and clinically sound research studies. The years searched ranged from January 1, 1980 - December 31, 2023 using the key words: osteoarthritis, knee, and Tai Chi. All potential articles were first carefully scanned for relevance, and excluded if they were non-English based articles, or proposals for study, or did not focus on osteoarthritis or its analogues. Because this review sought to make a strong case for Tai Chi in the context of home based preventive care for older adults with osteoarthritis, the review was largely focused on exploring a variety of associated empirical studies related to community based environments and samples of older adults with knee osteoarthritis. All forms of Tai Chi were deemed acceptable, as a single best application approach remains elusive, and all forms of research were deemed acceptable. The voluminous literature could not be reported on and readers are encouraged to examine the listed systematic reviews highlighted in this overview for more in depth analyses.

Results

General findings

Despite decades of inquiry, current data reveal enormous gaps in our knowledge bases plus an immense need to explore remedies that can prevent or ameliorate knee joint osteoarthritis in the elderly, as well as possibly retard its progression and magnitude with few side effects or safety concerns. However, with no evident curative measure or one that can mitigate this disease effectively as of 2023, and the possible harm that can ensue from the unrestricted need and usage of some medical agents, such as opioids, more attention to non pharmacologic approaches have been advocated for some time. In this regard many clinical papers imply exercises of varying modes to be highly related with the needs of many in this regard, even if surgery has been performed or will be forthcoming. This approach however, is often conducted sporadically, with programmatic adherence rates that are poor to marginal at best in many cases. Others show a further insult to an osteoarthritis knee joint is likely among those who are found to fall recurrently and become sedentary thereafter. As a result, and by contrast to other areas of osteoarthritis care and clinical research, a carefully designed and tailored exercise regimen that is acceptable as well as enjoyable and health affirming and requires no major investments of time or funds, may prove compatible with the diverse needs of many older adults suffering from knee osteoarthritis.

Moreover, if we consider that knee osteoarthritis has multiple physical and psychological attributes that extend beyond the local joint site, data on Tai Chi from multiple sources generally tend to show the exercises can impact multiple health correlates simultaneously at low energy and financial cost. For example, Tai Chi practice may help to foster a more relaxed mind, a calmer spirit, and improvements in self-image that may be very helpful in terms of reducing the immense stress associated with this knee osteoarthritis. It may also improve motivation for self-management and joint protection. Among other benefits of the flowing Tai Chi movements are a possible improved blood oxygen level and flow, as well as blood pressure rating plus psychological benefits regardless of mode of Tai Chi employed. Recent data also allude to the probable benefits of extending Tai Chi health effects by efforts to routinely consider the nature of the prevailing health conditions, and the tailoring of Tai Chi exercise instruction

styles accordingly to foster Tai Chi Asian originating exercise adoption and maintenance [14].

That is, even if publication bias cannot be ruled out, sufficient evidence attests to its safety and efficacy record and especially pain in older adults if practiced regularly [15]. In this regard, Lee and Lee [16] found post Tai Chi positive impacts on pain and stiffness, as well as balance, and fear of falling, a strong predictor in cases with knee osteoarthritis.

In addition to favorable cognitive and immune system effects post-Tai Chi practice [21-23], Brismee et al. [24] also found that home-based Tai Chi training resulted in older knee osteoarthritis participants having less knee pain, and better physical function. Similarly, Song et al. [25] showed that after a 6-month study period, subjects in the experimental group had significantly greater knee extensor endurance than the controls, plus significantly greater bone mineral density in the neck of the proximal femur, Ward's triangle, and trochanter. The fear of falling during daily activities was reduced significantly in the Tai Chi group compared to the control group.

Later, Wang et al. [26] identified significantly greater improvements in depression and the physical component of the quality of life measure in cases with knee osteoarthritis who practiced Tai Chi for an extended period. In another recent study [27] subjects undertaking Tai Chi had significantly improved primary as well as secondary outcomes including improving sleep and life quality.

Additional observations

As well as the stand alone studies highlighted above, available meta-analyses have been generally supportive of the potential of Tai Chi participation, including summative articles by Hu et al. [28], Kelley et al. [29] and Zhang et al. [30] regardless of study approach and selection. Most conclude Tai Chi participation improves disease-specific symptoms of pain and stiffness, and effectively improves body functioning, walking function, postural control, and mental quality of life [31-33]. Tai Chi is also deemed safe for individuals with different chronic conditions.

According to Duan et al. [34], compared with walking often advocated for knee osteoarthritis rehabilitation, adherence to Tai Chi practices may also safely yield improvements in hip range of motion and coordination of the neuromuscular system.

Indeed, Rogers et al. [35] has noted that older adults who participate in Tai Chi and who appear to improve physical function, also show reductions in blood pressure, fall risk, and depression and anxiety, all outcomes of great import to the knee osteoarthritis sufferer even if they are healthy otherwise. Other data reveal Tai Chi may specifically stimulate bone growth and strengthen connective tissue [36], while improving joint proprioception and balance [37-39]. In addition, results of Tai Chi practice that are observed include stress reduction, an improved ability to concentrate, and the adoption of a tranquil state of mind [40] as well as showing significant benefits for relieving lower limb osteoarthritis symptoms [30] such as pain, and stiffness [41-43].

In sum, although no data reporting on osteoarthritis molecular responses to Tai Chi were currently identified, and muscle improvements such as the rate of force development post Tai Chi as well as joint and muscle structural features are basically unknown, Tai Chi appears highly efficacious for promoting the subjective well being of those older adults who have been studied to date and are said to suffer from one or more forms of osteoarthritis. These benefits are very important to note, given that they can be attained safely at almost no cost, and appear to help this group overcome multiple rather than single health challenges, which are not limited to physical benefits alone, and their further impacts on the joint in question may prove highly valuable. Moreover, in a disease that often has few treatment options that can impact the disease itself effectively and favourably, the potential physical benefits observed to date

including improvements in strength, reductions in stress and increased energy, increased control over one's own health, without applying stress to the joints, and improved joint stability are all beneficial outcomes that can potentially slow the progress of the disease, even if the disease is not reversible.

Very interestingly cognitive benefits [45], as well, is the fact that although data often reveal exercise is not well adhered to in general as a health measure, Yau [46] recounts Tai Chi exercise is often chosen by the elderly for its gentle and soft movements. This may also be because besides its physical benefits, the benefits described by practitioners of this art form include lifestyle issues, as well as psychological and social benefits. Moreover, findings from numerous studies support the belief that the practice of Tai Chi has multiple personal benefits, not only physical benefits, and is generally pleasurable as outlined in Box 1.

Box 1. Selected Problems Commonly Faced by Older Adults with Symptomatic and Radiographic Knee Osteoarthritis Disability that could be Addressed by Tai Chi [*=factors that inhibit mobility; **=factors that could be exacerbated as a result of a fall]

Knee osteoarthritis
↓
Biological problems +

Physical challenges of:

- Chronic pain*/^^
- Frailty*/**
- Gait adjustments*
- Joint inflammation/swelling*/**
- Increased risk for falling
- Joint instability*/**
- Joint stiffness*
- Muscle weakness and wasting*/**
- Limited joint range of motion*
- Limited mobility and function*
- Obesity*
- Poor endurance capacity*
- Poor posture*/**
- Reduced balance capacity*

+

Psychological attributes of

- Depression and/or anxiety*/**
- Feelings of helplessness*/**
- Fatigue, and lack of energy*
- Limited confidence in ability to function/control pain**
- Sleep disturbances**
- Stress**

+

- Chronic health conditions*
- Innate joint damage linked immune responses
- Socioeconomic challenges**
- Social isolation

References: 1-7, 10, 47-49

Mechanisms of action

Theories of why Tai Chi can affect favourable outcomes specifically among people who suffer from osteoarthritis of one or more joints, are first, that the physical movement itself, which closely resembles those used in most western physical therapy rehabilitation settings, improves flexibility and builds muscle strength, within the limits of the individual patient's potential [10]. Another is its holistic approach that integrates the physical body with the emotions and spirit [44]. Tai Chi is also found to improve brain metabolism and muscle energetics in older adults [45] and has biomechanical benefits that help stabilize the knee joint in response to Tai Chi exercises [47, 48].

Liu et al. [49] who strove to compare the modulating effects of differing exercise modes on areas of the brain which play important roles in descending opioid associated pathways and reward/motivation systems in patients with knee osteoarthritis found positive results for Tai Chi. These included multiple benefits comparable to other forms of 12 weeks of exercise.

A pilot study of Tai Chi exercises applied for 8 weeks to 12 postmenopausal women with knee osteoarthritis has further identified a role for cortico-amygdala interactions related to Tai Chi and pain and physical function in subjects with knee osteoarthritis pain [50]. Another has shown a form of adapted Tai Chi termed Bafa Wubu yielded a positive significance for force attenuation of the joints of the lower extremities [51]. In addition, various Tai Chi motions activated muscles of different types at different levels that may prove highly functional for purposes of reducing the disease severity and its rate of progression and extent [48].

According to Zhu et al. [52] the use of four Tai Chi movements characterized by a wide motion range of lower limbs, can foster joint status through its impact on introducing slow increases in joint loading during exercises, while fostering strong muscle activity during its performance. In addition to fostering proprioception [53], plus falls self-efficacy [54], these self generated Tai Chi movements especially those that emulate daily life tasks to a degree, could be highly suitable for older adults with knee osteoarthritis who often need to improve the strength of their lower limb muscles and functional ability, avoid falls injuries and others, and remain cognitively alert, especially if they want to remain independent [56].

Discussion

Given the overall failure of modern medicine to counter or prevent disability associated with knee osteoarthritis, the most common joint condition that causes untold distress among senior members of all societies, a wealth of research has focused on its amelioration via medication and surgery for many years. Although only somewhat successful, as a form of self-care and overall form of health promotion that may raise the ability of the older knee osteoarthritis sufferer to overcome any disease associated sedentary tendencies, Tai Chi, interchangeably known as Tai Chi Chuan, is an ancient health-promoting martial art form that has been recognized in Asia as an effective form of arthritis therapy for centuries and may yet prove of high value in Western contexts where it is not well studied or commonly advocated.

Indeed, an increasing volume of careful research from Asia in particular shows that the low to moderately intensity type of exercise programs that follow Tai Chi precepts or their modifications as indicated [48] may prove especially effective in fostering both health in general, as well as knee joint viability, in particular. Importantly, unlike many forms of traditional exercise that use movements and muscle patterns that are often quite different from those used in daily life, such as those conducted in

water, or statically in one knee position, or via a series of fatiguing movements, Tai Chi exercise employs slow graceful, low impact, low velocity functional movements that do not include a lot of bending or impact. They thus seem particularly appropriate for older individuals often affected by painful knee osteoarthritis and one or more chronic health challenges, such as heart disease. Even though they induce relatively low stress impact on joints if carefully construed, they can still help to strengthen the knee muscles as well as balance of the affected leg quite markedly [57, 58] and falls risk [59, 60]. Tai Chi practice can also safely enhance aerobic capacity, which can improve functional capacity and social participation, while improving life quality [61-63].

Tai Chi thus seems to be consistent in its ability to enable older adults and others with knee osteoarthritis to live better lives and possibly to have better long-term outcomes even if surgery is still needed or is carried out. Self-reports of enjoyment by people participating in Tai Chi, indicate this form of exercise may not only be adhered to but its mode of usage is sufficiently flexible to accommodate different people's needs and preferences for exercise quite successfully. Participants who feel infused with energy as a result, may also be able to continue their desired physical activity levels and social interactions for years to come at minimal cost. Associated with an exercise intensity that may be less injurious to joints than commonplace high intensity exercises often advocated for improving aerobic capacity, it appears Tai Chi practice is especially likely to foster independence and well-being, such as reductions in pain and cardiovascular disease symptoms, among other health benefits. These movements, which incorporate deep breathing, while maintaining an upright posture are designed to soothe rather than stress, and are hence very important in the context of osteoarthritis treatments, where it is crucial to place no undue strain on the affected muscles, joints, and connective tissues surrounding the diseased joints, and where cognitive stress is a feature as well. They can also be effectively combined with resistance training exercises to enhance effects of exercise in older adults.

This is important given that most patients with osteoarthritis will commonly fail to participate in activities that are perceived as difficult and painful, or that have few desirable health benefits, especially if the activity worsens their joint pain. The large benefits of Tai Chi exercise on knee extensor strength, proprioception and postural stability may not only counteract pain effectively but may also foster better balance control, as well as less overall joint damage and proclivity to injury, such as falls that can lead to a hastening of progressive disability and disablement [64, 65]. In addition to all these potential benefits, programs using alternative exercise approaches such as Tai Chi may prove especially beneficial for those who cannot take medication, but who have considerable degrees of pain, given the evidence that pain can be reduced substantially, even if the exercises are only practiced one per week.

As the ability to employ technology to assess joint pathology, and muscle related factors unfolds, continued investigations to understand how to harness impactful Tai Chi attributes, as well as what movements to avoid should prove of immense relevance at any point in the preventive spectrum against excess disability, costs, and suffering and is strongly encouraged.

More advanced analyses that examine the direct impacts or interactions of various modes of Tai Chi on bone, muscle coordination, and muscle atrophy in pathological knee joints and others are also indicated. To strengthen the evidence base more comprehensive comparative prospective studies, studies carried out in Western as well as Eastern contexts among high aged and chronically debilitated older adults are indicated as well.

In the interim, and possibly under the guidance of qualified practitioner and health provider, it appears multiple clinically oriented health benefits are likely to emerge in response to the practice of a

personalized long term Tai Chi program, regardless of mode of Tai Chi employed.

Conclusions

In light of the strong need to offer some degree of relief to the older adult with knee osteoarthritis, a growing volume of literature attests to the potential for Tai Chi exercise participation not only for both reducing the disease burden, but for allaying the pain and joint destruction processes associated with the disease, even if more research is warranted.

In the interim:

- * It appears Tai Chi may also assist in helping this group to maintain a favorable health profile, despite associated commonplace health issues and has beneficial falls mitigation attributes as well.
- * Safe and easy to apply in or outdoors, in standing, or sitting, alone or in a group, multiple associated benefits appear to include fatigue amelioration, sleep health, falls, obesity, postural stability and motor control [66], it appears to apply to all degrees of pathology and any form of Tai Chi practice.
- * Along with a very careful clinically oriented pre exercise evaluation, plus efforts to then disseminate user friendly directives, is clearly of high importance, especially for those with concomitant pathologies such as diabetes, and cardiovascular diseases that are not only shared with falls injury risk but also with increased pain and disability. Moreover, different osteoarthritis treatments such as NSAIDs, paracetamol, corticosteroids, opioids or other molecules have a wide array of iatrogenic effects that provoke falling and joint damage rather than protection.

In short, the benefits of the slow gentle movements of Tai Chi as applied to older adults with osteoarthritis as well as other chronic lionesses appear to have considerable promise. As such, physicians, allied health workers, and others can be fairly certain that even if they cannot consult with their osteoarthritis patients in a face to face manner for various reasons, they can still help their older osteoarthritis clients to better their health status and functional ability, while reducing their pain, any frailty or obesity risk, as well as excess anxiety and depression by recommending Tai Chi and resource access.

It is also concluded that as with standard care approaches, knee osteoarthritis cases should be screened for their falls risk periodically at their annual or regular visits, as well as pre joint replacement surgery. They should be made aware of their falls risk and their help should be sought in averting falls in the future rather than ignored even after surgery.

Providers can also help by directing clients to an instructor or group, plus making instructive videos, audio tapes, and written documents in understandable terms available and accessible in this regard and keeping adequate progress records.

In essence, although more research using carefully designed ecologically sound protocols are crucial to support Tai Chi as a potential key mainstream osteoarthritis intervention, it appears knee osteoarthritis disease mitigation may be anticipated to varying degrees consequent to carefully designed and conducted regular Tai Chi protocols.

As opposed to most current intervention approaches, individualized as well group Tai Chi activities conducted regularly can be expected to yield multiple beneficial social as well as physical, and psychological influences, while fostering the ability of the affected adult to function physically at low cost. Costs to society may be duly impacted favorably as well and thus investments in this regard are

strongly encouraged.

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Conflicts of interest

The author has no conflict of interest to declare.

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References

1. Song J, Wei L, Cheng K, Lin Q, Xia P, et al. (2022) The effect of modified tai chi exercises on the physical function and quality of life in elderly women with knee osteoarthritis. *Front Aging Neurosci.* 14:860762. doi: 10.3389/fnagi.2022.860762.
2. Geng R, Li J, Yu C, Zhang C, Chen F, et al. (2023). Knee osteoarthritis: current status and research progress in treatment (Review). *Exp Ther Med.* 26(4):481. doi: 10.3892/etm.2023.12180. .
3. Huston P, McFarlane B. Health benefits of tai chi: (2016). What is the evidence? *Can Fam Physician.* 62(11):881-890.
4. Patterson BE, Girdwood MA, West TJ, Bruder AM, Øiestad BE, et al. (2023). Muscle strength and osteoarthritis of the knee: a systematic review and meta-analysis of longitudinal studies. *Skeletal Radiol.* 52(11):2085-2097. doi: 10.1007/s00256-022-04266-4. .
5. Rosenberg JH, Rai V, Dilisio MF, Agrawal DK. (2017). Damage-associated molecular patterns in the pathogenesis of osteoarthritis: potentially novel therapeutic targets. *Mol Cell Biochem.* 34(1-2):171-179. doi: 10.1007/s11010-017-3047-4.
6. Aljehani MS, Crenshaw JR, Rubano JJ, et al. (2021). Falling risk in patients with end-stage knee osteoarthritis. *Clin Rheumatol.* 40(1):3-9.
7. Chen J, Xue X, Xu J, Zeng J, Xu F. (2022). Emerging trends and hotspots in tai chi fall prevention: analysis and visualization. *Int J Environ Res Public Health.* 19(14):8326. doi: 10.3390/ijerph19148326.
8. Allen J, Morelli V. (2011). Aging and exercise. *Clin Geriatr Med.* 2011;27(4):661-671. doi:10.1016/j.cger.2011.07.01020.
9. Barrow DR, Abbate LM, Paquette MR, Driban JB, Vincent HK, et al. (2019). Exercise prescription for weight management in obese adults at risk for osteoarthritis: synthesis from a systematic review. *BMC Musculoskeletal Disorders.* 20(1):610. doi:10.1186/s12891-019-3004-3
10. Lee EH, Lee KS, So AY, Choi JS, Lee IO, et al. (2007). Effect of self-help Tai Chi for arthritis on the quality of life, health perception, joint flexibility, grasping power, and balance. *J Muscle Joint Hlth.* 14(2):127-136.
11. Wellsandt E, Golightly Y. (2018). Exercise in the management of knee and hip osteoarthritis. *Curr Opinion Rheumatol.* 30(2):151-159. doi:10.1097/BOR.0000000000000478
12. Wang X, Si K, Gu W, Wang X. (2003). Mitigating effects and mechanisms of Tai Chi on mild cognitive impairment in the elderly. *Front Aging Neurosci.* 14:1028822. doi: 10.3389/

- fnagi.2022.1028822.
13. Zhuang SZ, Chen PJ, Han J, Xiao WH. (2023). Beneficial effects and potential mechanisms of tai chi on lower limb osteoarthritis: a biopsychosocial perspective. *Chin J Integr Med.* 29(4):368-376. doi: 10.1007/s11655-021-3529-9.
 14. Du Y, Roberts P, Liu W. (2023) Facilitators and barriers of tai chi practice in community-dwelling older adults: qualitative study. *Asian Pac Isl Nurs J.* 7:e42195. doi: 10.2196/42195.
 15. You T, Leveille SG, Yeh GY, Wayne PM. (2023). Is Tai Chi beneficial for multisite pain syndrome in older adults? *Aging Clin Exp Res.* 35(7):1443-1448. doi: 10.1007/s40520-023-02439-2.
 16. Lee HY, Lee KJ. (2008). Effects of Tai Chi exercise in the elderly with knee osteoarthritis. *Taehan Kanho Hakhoe Chi.* 38(1):11-18. doi:10.4040/jkan.2008.38.1.11
 17. Hartman CA, Manos TM, Winter C, Hartman DM, Li B, et al. (2000). Effects of T'ai Chi training on function and quality of life indicators in older adults with osteoarthritis. *J Am Geriatr Soc.* 48(12):1553-1559.
 18. Adler P, Good M, Roberts B, Snyder S. (2000). The effects of Tai Chi on older adults with chronic arthritis pain. *J Nurs Scholarship.* 32(4):377.
 19. Song R, Lee EO, Lam P, Bae SC. (2003). Effects of tai chi exercise on pain, balance, muscle strength, and perceived difficulties in physical functioning in older women with osteoarthritis: a randomized clinical trial. *J Rheumatol.* 30(9):2039-2044.
 20. Yip YB, Sit JWH, Wong DS. (2004). A quasi-experimental study on improving arthritis self-management for residents of an aged people's home in Hong Kong. *Psy, Health Med.* 9(2):235-246.
 21. Zhou M, Liao H, Sreepada LP, Ladner JR, Balschi JA, et al. (2018). Tai Chi improves brain metabolism and muscle energetics in older adults. *J Neuroimaging.* 28(4):359-364. doi:10.1111/jon.12515
 22. Zou L, Loprinzi PD, Yu JJ, Yang L, Li C, et al. (2019). Superior effects of modified Chen-style Tai chi versus 24-style Tai chi on cognitive function, fitness, and balance performance in adults over 55. *Brain Sci.* 9(5):102. doi:10.3390/brainsci9050102
 23. Shen CL, Newman JW, Elmassry MM, Borkowski K, Chyu MC, et al. (2023). Tai Chi exercise reduces circulating levels of inflammatory oxylipins in postmenopausal women with knee osteoarthritis: results from a pilot study. *Frontiers Med.* 2023;10.
 24. Brismée JM, Paige RL, Chyu MC, Boatright JD, McCaleb JA, et al. (200). Group and home-based tai chi in elderly subjects with knee osteoarthritis: a randomized controlled trial. *Clinical Rehabil.* 21(2):99-111. doi:10.1177/0269215506070505
 25. Song R, Roberts BL, Lee EO, Lam P, Bae SC. (2010). A randomized study of the effects of T'ai Chi on muscle strength, bone mineral density, and fear of falling in women with osteoarthritis. *J Alternative Complement Med.* 16(3):227-233. doi:10.1089/acm.2009.0165
 26. Wang C, Schmid CH, Iversen MD, Harvey WF, Fielding RA, et al. (2016). Comparative effectiveness of Tai Chi versus physical therapy for knee osteoarthritis: a randomized trial. *Ann Int Med.* 165(2):77-86. doi:10.7326/M15-2143

27. Lü J, Huang L, Wu X, Fu W, Liu Y. (2017). Effect of Tai Ji Quan training on self-reported sleep quality in elderly Chinese women with knee osteoarthritis: a randomized controlled trial. *Sleep Medicine*. 33:70-75. doi:10.1016/j.sleep.2016.12.024
28. Hu L, Wang Y, Liu X, Ji X, Ma Y, et al. (2021). Tai Chi exercise can ameliorate physical and mental health of patients with knee osteoarthritis: systematic review and meta-analysis. *Clin Rehabil*. 35(1):64-79. doi: 10.1177/0269215520954343.
29. Kelley GA, Kelley KS, Callahan LF.(2022). Clinical relevance of Tai Chi on pain and physical function in adults with knee osteoarthritis: an ancillary meta-analysis of randomized controlled trials. *Sci Prog*. 105(2):368504221088375. doi: 10.1177/00368504221088375.
30. Zhang N, Cui H, Li H, Yang Y, Gao Z, et al. (2023). Effects of Tai Chi in knee osteoarthritis patients: an overview of systematic reviews and meta-analyses. *Complement Ther Med*. 77:102978. doi: 10.1016/j.ctim.2023.102978.
31. You T, Ogawa EF, Thapa S, Cai Y, Zhang H, et al. (2018). Tai Chi for older adults with chronic multisite pain: a randomized controlled pilot study. *Aging Clin Exp Res*. 30(11):1335-1343. doi: 10.1007/s40520-018-0922-0.
32. Ye Y, Liu A. (2023). The effectiveness of Tai Chi for knee osteoarthritis: an overview of systematic reviews. *Int J Gen Med*. 16:4499-4514. doi: 10.2147/IJGM.S434800.
33. Kang N, Wang Y, Chen G, Guo C, Zhang Z, et al. (2022). Functional outcomes of Tai Chi exercise prescription in women with knee osteoarthritis. *Sports Med Health Sci*. 4(4):239-244. doi: 10.1016/j.smhs.2022.10.001.
34. Duan J, Wang K, Chang T, Wang L, Zhang S, et al. (2019). Tai Chi is safe and effective for the hip joint: a biomechanical perspective. *J Aging Phys Activity*. 1-11. doi:10.1123/japa.2019-0129
35. Rogers CE, Larkey LK, Keller C. (2009). A review of clinical trials of tai chi and qigong in older adults. *Western J Nurs Res*. 31(2):245-279. doi:10.1177/0193945908327529
36. Li J, Guo J, Wang X, Zhang X, Zhang Y, et al. (2023). Efficacy and safety of tai chi exercise on bone health: an umbrella review. *Osteoporos Int*. 34(11):1853-1866. doi: 10.1007/s00198-023-06830-7.
37. Huang CY, Mayer PK, Wu MY, Liu DH, Wu PC, et al. (2022). The effect of Tai Chi in elderly individuals with sarcopenia and frailty: a systematic review and meta-analysis of randomized controlled trials. *Ageing Res Rev*. 82:101747. doi: 10.1016/j.arr.2022.101747.
38. Bubela D, Sacharko L, Chan J, Brady M. (2019). Balance and functional outcomes for older community-dwelling adults who practice Tai Chi and those who do not: a comparative study. *J Geriatr Phys Ther*. 42(4):209-215. doi: 10.1519/JPT.000000000000153.
39. Xu F, Soh KG, Chan YM, Bai XR, Qi F, et al. (2023). Effects of Tai Chi on postural balance and quality of life among the elderly with gait disorders: a systematic review. *PLoS One*. 18(9):e0287035.
40. Liu Y, Mimura K, Wang L, Ikudu K. (2003). Physiological benefits of 24-style Taijiquan exercise in middle-aged women. *J Phys Anthropol Appl Human Sci*. 22(5):219-225.
41. Chang WD, Chen S, Lee CL, Lin HY, Lai PT. (2016). The effects of Tai Chi Chuan on improving mind-body health for knee osteoarthritis patients: a systematic review and meta-analysis. *Evid Based Complement Alternat Med*. 2016:1813979. doi: 10.1155/2016/1813979.

42. Field T. (2016). Knee osteoarthritis pain in the elderly can be reduced by massage therapy, yoga and tai chi: a review. *Complement Ther Clin Pract.* 22:87-92. doi: 10.1016/j.ctcp.2016.01.001.
43. Lauche R, Langhorst J, Dobos G, Cramer H. (2013). A systematic review and meta-analysis of Tai Chi for osteoarthritis of the knee. *Complement Ther Med.* 21(4):396-406. doi: 10.1016/j.ctim.2013.06.001.
44. Boniface SP. (2018). *Tai Chi for Seniors*. The Career Press Inc., Franklin Lakes, NJ.
45. Zhou M, Liao H, Sreepada LP, Ladner JR, Balschi JA, et al. (2018). Tai Chi improves brain metabolism and muscle energetics in older adults. *J Neuroimaging.* 28(4):359-364. doi: 10.1111/jon.12515.
46. Yau MK. (2008). Tai Chi exercise and the improvement of health and well-being in older adults. *Med Sport Sci.* 52:155-165. doi:10.1159/000134296
47. Huston P. (2023) Why osteoarthritis of the knee is called "a wound that does not heal" and why Tai Chi is an effective treatment. *Front Med (Lausanne).* 10:1208326. doi: 10.3389/fmed.2023.1208326.
48. Liu H, Gong H, Chen P, Zhang L, Cen H, et al. (2023). Biomechanical effects of typical lower limb movements of Chen-style Tai Chi on knee joint. *Med Biol Eng Comput.* 61(11):3087-3101. doi: 10.1007/s11517-023-02906-y.
49. Liu J, Chen L, Chen X, Hu K, Tu Y, et al. (2019). Modulatory effects of different exercise modalities on the functional connectivity of the periaqueductal grey and ventral tegmental area in patients with knee osteoarthritis: a randomised multimodal magnetic resonance imaging study. *Brit J Anaesthesia.* 123(4):506-518.
50. Shen CL, Watkins BA, Kahathuduwa C, Chyu MC, Zabet-Moghaddam M, et al. (2022). Tai Chi improves brain functional connectivity and plasma lysophosphatidylcholines in postmenopausal women with knee osteoarthritis: an exploratory pilot study. *Front Med (Lausanne).* 8:775344. doi: 10.3389/fmed.2021.775344.
51. Li H, Peng F, Lyu S, Ji Z, Li X, Liu M. (2023). Newly compiled Tai Chi (Bafa Wubu) promotes lower extremity exercise: a preliminary cross sectional study. *Peer J.* 11:e15036. doi: 10.7717/peerj.15036.
52. Zhu Q, Zhou X, Zhang S, Fang M, Li JX. (2021). Joint angles and joint moments of the lower limbs in four typical Tai Chi movements: consideration for management of knee osteoarthritis. *Res Sports Med.* 29(6):586-592.
53. Xu D, Hong Y, Li J, Chan K. (2004). Effect of Tai Chi exercise on proprioception of ankle and knee joints in old people. *Brit J Sports Med.* 38(1):50-54. doi:10.1136/bjism.2002.003335
54. Tong Y, Chai L, Lei S, Liu M, Yang L. (2018). Effects of Tai Chi on Self-Efficacy: A Systematic Review. *Evid Based Complement Alternat Med.* 2018:1701372. doi: 10.1155/2018/1701372.
55. Huston P, McFarlane B. (2016). Health benefits of Tai Chi: what is the evidence?. *Can Family Physician.* 62(11):881-890.
56. Penn IW, Sung WH, Lin CH, Chuang E, Chuang TY, et al. (2019). Effects of individualized Tai-Chi on balance and lower-limb strength in older adults. *BMC geriatrics.* 19(1):1-8.
57. Bai X, Xiao W, Soh KG, Agudamu, Zhang Y (2023) 12-week concurrent brisk walking and Taijiquan (Tai Chi) improve balance, flexibility, and muscular strength of Chinese older women. *PLoS ONE* 18(10): e0293483. <https://doi.org/10.1371/journal.pone.0293483>

58. Wu G, Zhao F, Zhou X, Wei, L. (2002) Improvement of isokinetic knee extensor. Strength and reduction of postural sway in the elderly from long-term Tai-Chi exercise. *Arch Phys Med Rehabil.* 83(10):1364-1369.
59. Chen W, Li M, Li H, Lin Y, Feng Z. (2023). Tai Chi for fall prevention and balance improvement in older adults: a systematic review and meta-analysis of randomized controlled trials. *Frontiers Public Health.* 2023;11.
60. Bannuru RR, Abariga S, Wang C. (2012). How effective is tai chi mind-body therapy for knee osteoarthritis (KOA)? A systematic review and meta-analysis. *Osteoarthritis and Cartilage.* 20:S281-282.
61. Yang GY, Hunter J, Bu FL, Hao WL, Zhang H, et al. (2022). Determining the safety and effectiveness of Tai Chi: a critical overview of 210 systematic reviews of controlled clinical trials. *Syst Rev.* 11(1):260. doi: 10.1186/s13643-022-02100-5.
62. You Y, Liu J, Tang M, Wang D, Ma X. (2021) Effects of Tai Chi exercise on improving walking function and posture control in elderly patients with knee osteoarthritis: A systematic review and meta-analysis. *Medicine (Baltimore).* 100(16):e25655. doi: 10.1097/MD.00000000000025655.
63. Ma Y, Wang C, Peng Q, Hou A, Li Y, Hu R, Yin Y. (2023). Effects of mind-body therapies in knee osteoarthritis: a systematic review and network meta-analysis. *Arch of Med Sci.*
64. Yang F, Liu W. (2021). Individual analysis of dynamic stability for twenty-four Tai Chi forms among persons with knee osteoarthritis: a pilot study. *Gait & Posture.* 86:22-26.
65. Makri ED, Iakovidis P, Lytras D, Fetlis A, Kasimis K, et al. (2023). The effect of tai chi on balance, fear, and reduction of falls in older adults: a narrative review. *Int J Orthopaedics.* 9(1):184-187.
66. Ghandali E, Moghadam ST, Hadian MR, Olyaei G, Jalaie S, et al. (2017). The effect of Tai Chi exercises on postural stability and control in older patients with knee osteoarthritis. *J Bodyworks Movement Ther.* 21(3):594-598. doi:10.1016/j.jbmt.2016.09.001