Tai Chi for the Prevention of Fractures in a Nursing Home Population: An Economic Analysis

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- *Objective:* To ascertain the relative costs versus benefits of implementing a tai chi program in a typical nursing home.
- *Design:* Literature-based cost-benefit analysis.
- *Data sources:* Direct benefits were calculated from literature-based estimates and were restricted to hip fracture costs averted. Indirect benefits were calculated using the concept of willingness to pay to prevent morbidity or mortality.
- *Target population:* Nursing home residents at average risk for fall.
- *Time horizon:* 1 year.
- *Intervention modeled:* Twice weekly *Yang*-style tai chi classes.
- *Results:* Tai chi was cost-saving whether direct benefits alone (hip fracture costs averted) or direct plus indirect benefits were considered, with a total net cost savings of $1274.43 per person per year. When considering direct costs only, the net cost savings was $8.04 per participant per year. The model suggested that a tai chi intervention could avert 49.875 falls per 100 participants annually, at a cost of $172.68 per fall averted. Approximately 200 patient-years of tai chi exposure were required to prevent 1 hip fracture, at a cost of $17,268.17 per hip fracture averted, whereas 800 patient-years of tai chi exposure were needed to prevent 1 death, at a cost of between $64,294 and $66,694. Consideration of additional fall-related expenses would significantly broaden the economic feasibility of a tai chi intervention.
- *Conclusion:* Tai chi is an economically feasible intervention to prevent hip fracture in nursing home residents. Despite the economically favorable analysis, policy makers are advised to await confirmatory studies of tai chi's effectiveness and utility within this population before instituting such a program.

Falls are the sixth leading cause of death among persons older than 65 years [1]. Nonfatal falls are frequently associated with significant physical and psychological morbidity and resultant functional deterioration. Among fall-related injuries, fractures of the hip incur the greatest morbidity and highest direct medical costs [2]. Hip fractures cause hospitalization, disability, and loss of independence for an estimated 300,000 persons annually [3] at a cost of more than $8.6 billion [2]. The high risk of hip fracture among the fastest-growing segment of the population calls for prioritizing evaluations of techniques to prevent falls.

Intrinsic risk factors for falls include protective reflexes, muscle and bone strength, and soft tissue energy absorption [4], all of which are diminished in the frail and often sarcopenic institutionalized elderly. Tai chi, a martial arts-based exercise, has shown substantial promise in fall prevention via its modulation of these intrinsic risk factors. It is unclear, however, whether the institution of a structured tai chi program in a nursing home setting is economically feasible. The uncertainty regarding the relative costs versus impact of tai chi for the prevention of osteoporotic fractures in nursing home residents serves as a basis for the current cost-benefit analysis.

Background on Tai Chi and Literature Review

Although subject to age-related decrements [5], balance has been shown to be responsive to training [6]. Tai chi appears to stress balance mechanisms while facilitating an enhanced appreciation of one's body position within the environment. Movements are performed using a graduated combination of spatial orientations and weight shifts. Because tai chi is carried out with a lowered center of gravity with resultant hip and knee flexion, strengthening of associated muscle groups may occur. Lan et al's [7] reported increases in concentric and eccentric knee extensor peak torque of 15.1% to 20.0% support this theory. While health screening followed by an intervention targeting multiple identified risk factors has produced statistically significant protection against falling (odds ratio, 0.61) [8], balance training alone has not been shown to reduce the risk of falls. This suggests that the benefits of tai chi involve mechanisms in addition to improved balance.

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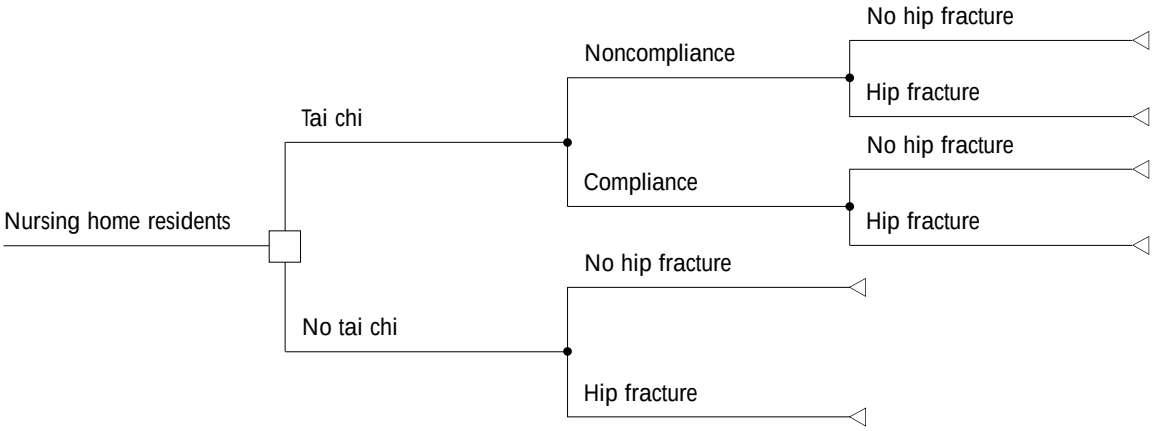

Figure 1. Decision tree for tai chi intervention using hip fracture as main outcome variable.

The Atlanta FICSIT (Frailty and Injuries: Cooperative Studies of Intervention Techniques) study [9] was a single-blinded randomized investigation with 3 arms: tai chi, computerized balance training, and education. The 72 participants randomized to 15 weeks of twice-weekly, 45-minute tai chi sessions were found to have lower blood pressure and reduced fear of falling at 4 months. Adjusting for fall risk factors, tai chi but not balance training was found to reduce the risk of multiple falls by 47.5%. Home practice was not monitored in this study, and the dropout rate was reported as 8%.

Tse et al [10] demonstrated that regular tai chi practice could significantly improve participants' balance control in 3 of 5 clinical tests compared with controls. Likewise, Ross et al [11] demonstrated improved balance, sway, and range of motion but also decreased anxiety and perceived pain in tai chi practitioners. Wolfson et al [12], reporting from the Connecticut FICSIT group, found that 26 weekly tai chi sessions resulted in significant improvement in the maintenance of balance gains achieved through a 3-month balance-training program. In this study, the compliance rate for tai chi sessions was 72%. More recently, Lin et al [13], Hong et al [14], and Hain et al [15] reported that regular tai chi sessions result in postural stability, balance control, flexibility, and cardiovascular fitness, respectively. Hartman et al [16] were the first to report beneficial effects of tai chi on self-efficacy measures, quality of life, and functional mobility in older adults with osteoarthritis.

Data and Assumptions

The analysis assesses the relative costs and benefits of implementing a tai chi program in a typical nursing home unit in 2000. In this model, the tai chi intervention is administered to 100 nursing home residents at average risk for fall over a time horizon of 1 year. The decision model assumes an equal baseline fall risk in the nursing home resident cohort and an equal hip fracture risk in the event of a fall. For the purposes of this model, "nursing home" is considered to include assisted living and skilled nursing facilities. The tai chi intervention will consist of two 1-hour classes per week monitored by a certified tai chi instructor and an assistant. It is envisioned that a *Yang*-style routine will be utilized, as it is less athletic than the *Chen*-style. The intervention is assumed to be conceptually equivalent to that employed by the Atlanta FICSIT group and to consist of a gradual progression of slow, controlled movements that result in a reduction of the base of standing support until single limb stance is achieved. In addition to increased body and trunk rotation, emphasis is placed on flexion of hips and knees, weight shifting, reciprocal arm movements, balance, relaxation, deep breathing, and concentration. For the purposes of this analysis, it is assumed that the tai chi program will produce an effect on fall rate identical to that produced by the Atlanta FICSIT tai chi intervention [9]. While it is acknowledged that this study represents the only data available to indicate a protective effect of tai chi against fall, the methodology used by Wolf et al [9] is sound and incorporates standardized outcome measures. The comparison program used for the decision analysis is usual care delivered to the same residents. The conceptual model employed in this analysis is viewed from a societal perspective.

The decision tree is presented in **Figure 1**. All modeling and sensitivity analyses were performed using Data 3.5 (Treeage Software, Inc., Williamstown, MA). In this model, the cohort either receives tai chi or usual care. In each path, the number of falls over the 1-year intervention period is calculated and the possible outcomes are limited to hip fracture or no hip fracture. It is assumed that health resource utilization attributable to falls is dominated by hip fractures.

As such, if the tai chi intervention can be shown to be cost-beneficial when including only costs of hip fracture averted, then it stands to be even more cost-beneficial if the direct costs of all fall consequences are considered. It is unlikely that any program that requires a regular involvement on behalf of the participant will have a 100% compliance rate. For the purposes of this analysis, a 30% annual dropout rate is assumed, approximating the lower estimates for compliance derived from the literature. The decision model does not assume that dropouts are at higher risk of falling than participants, but in an attempt to counter this, the model assumes that any benefit from the program is lost at the time of withdrawal from the program.

All costs derived from the literature are converted to year 2000 costs. Direct costs were adjusted using the medical care component of the consumer price index, whereas willingness to pay costs were adjusted using the full consumer price index [17]. Typically in economic analyses, one adjusts for discounting. In the present analysis, however, the short-term benefits are expected to be sufficient enough such that long-term follow-up is not essential, hence obviating the discounting requirement.

Calculations and Results

Estimated Costs of Tai Chi Intervention

The predominant operating costs associated with a nursing home tai chi program are the financial compensation of the instructor and an assistant. Cost estimates were determined by discussions with a number of tai chi instructors across the United States. Cost estimates for instruction of 2 classes per week ranged from $75 per week in the Midwest to $200 per week on the East Coast. The average of these costs was multiplied by 52 to derive an annual instructor cost of $7150.

The large number of anticipated participants demands involvement from an assistant. It was reasoned that the assistant would in most likelihood be a member of the nursing home staff, either a physical therapy aide or a recreational therapist. Training costs for the assistant would likely consist of the costs of a training course and/or instructional videos. An internet search of the latter 2 products allowed the derivation of an assistant training cost of $1200.

It is assumed that there are no capital overheads in that most nursing homes have an area with sufficient floor space to house participants. The cost of recruitment of an instructor is presumed to be minimal, with instructors typically either listed in telephone directories or available through local community centers, YMCAs, fitness centers, and community colleges. It is assumed that there are no replacement or maintenance costs.

Since nursing home residents vary markedly in their physical and cognitive functional capacity, not all residents would have sufficient physical function or comprehension to participate in the program. Costs of screening patients to identify those who would attain the greatest benefit from tai chi were thus considered. It is understood that patients deemed inappropriate for the tai chi intervention may in many cases represent those at highest risk for falling. However, although the Atlanta FICSIT study [9] reported an overall relative risk (RR) for falls of 0.525 in the tai chi group compared with controls, it also reported a higher risk for falls in tai chi recipients compared with controls among those who had had falls in the year preceding the intervention (RR = 2.016) or who had a higher score on a fear of falling questionnaire (RR = 1.417). For this reason, the present model focuses only on residents at average fall risk.

It is assumed that registered nurses could identify 50 residents appropriate for a *Yang*-style tai chi intervention on the basis of a brief cognitive screen, formal or informal gait evaluation strategies, and chart review to exclude a history of falls. The time expended by nursing staff in completion of these assessments, typically 30 minutes, is the cost of screening. As not all residents screened would be deemed appropriate for the intervention, it was estimated that 75 residents would need to undergo screening to recruit 50 appropriate participants. Screening costs were therefore calculated as $75 \times 0.5 \times$ registered nurse hourly wage. Nursing hourly wages were based on an internet search [18,19] and personal communication from local skilled nursing facilities from which an hourly rate of $14 to $17 was derived. Using the upper estimate of $17 per hour, $262.50 is assumed to be the annual screening cost, bringing the total cost of the tai chi program for 1 year to $8612.50 (**Table 1**).

Estimated Benefits of Tai Chi Intervention

Direct benefits. Direct benefits are the direct costs avoided as a result of the tai chi intervention. These costs were estimated from a literature review of hip fracture hospitalization costs (**Table 2**) [2,20–26]. Where appropriate, charges were converted to costs using a global charge-to-cost ratio of 0.58 [27]. The direct hospital costs for treatment of hip fracture ranged from $10,916 to $15,476, with an average of $11,300. The incremental direct costs of the skilled nursing facility (including rehabilitation fees, Medicare part B physician payments, and other part B items, eg, orthopedic medical equipment) and repeat hospitalization costs for the first 6 months following hip fracture were derived from National Long Term Care Survey data [23]. These costs were summed and adjusted to 2000 dollars, resulting in an adjusted total of $7581. This cost was added to the aforementioned hospitalization costs to derive an estimate for total direct costs of hip fractures of $18,881. This figure does not represent the emergency room costs associated with 20% to 30% of falls or the direct costs of fractures at sites other than hip and is therefore an underestimate of total fall-related costs.

Table 1. Summary of Results

	With Tai Chi	Without Tai Chi
Cost of intervention		
Instructor	$7150.00	
Assistant training	$1200.00	
Patient screening	$262.50	
Total cost per year	$8612.50	$0
Number of falls per 100 residents	150 × 0.525 (relative risk of falling) = 78.75 (100% compliance)	150
	(0.3 × 150) + (0.7 × 78.75) = 100.125 (70% compliance)	
Number of falls averted per 100 recipients	150 – 100.125 = 49.875	0
Cost of hip fracture	$18,881 × 1.00125 = $18,905	$18,881 × 1.5 = $28,321.50
Cost of hip fracture + tai chi	$27,517.10	$28,321.50
Direct cost savings with tai chi	$804.40	$0
Direct cost savings per person	$8.04	$0
Cost per fall averted	$8612.50 ÷ 49.875 = $172.68	
Cost per hip fracture averted	$17,268.17	
Cost per death averted	$64,294 to $66,694	
Direct costs avoided	$8.04 per person per year	
Indirect morbidity avoided	$410.02 per person per year	
Indirect mortality avoided	$856.37 per person per year	
Total net benefit	**$1274.43 per person per year**	

The differential hip fracture rate in the tai chi group as compared with controls is used as the starting point for the cost-benefit analysis. It is not anticipated that the tai chi intervention will lessen the likelihood of hip fracture in the event of a fall. Estimates of fall and fracture rates for institutionalized elderly were obtained from literature review. The annual incidence of falling among nursing home residents is 1.5 falls per bed per year [28] with a range of 1.45 to 2.08 falls per bed per year [29–31]. In addition, 25% of nursing home residents are frequent fallers [32] with an annual average of 5.8 falls. Estimates of the proportion of falls that result in hip fracture range from less than 1% to ~2% [33–36]. For this reason a hip fracture rate of 1% in the event of fall was used. The probability of hip fracture in tai chi recipients was calculated by multiplying this rate by 0.525, the relative risk of fall in tai chi recipients compared with controls [9] and adjusted for a 70% compliance rate.

Compared to the option of no tai chi, the tai chi option would be expected to avert 49.875 falls and thus 0.49875 hip fractures per 100 participants per year. Given a hip fracture rate of 1% in the event of a fall, the hip fracture incidence is therefore 1.00125 hip fractures per 100 participants per year for the tai chi option and 1.5 hip fractures per 100 participants per year in the absence of tai chi. Given that the direct cost of a hip fracture in the tai chi recipients is $27,493.50 ($18,881 + $8,612.50), the potential costs are $27,517.10 ([$18,881 × 1.00125] + $8,612.50) in the tai chi group and $28,321.50 ($18,881 × 1.5) in the regular care group. The difference in these estimates, $804.40 per year for the group, or $8.04 per participant per year, is the expected direct net cost savings in the tai chi cohort. These calculations are summarized in Table 1. In addition, a plot of cost versus effectiveness is presented in **Figure 2**. Assuming no assistant training costs in subsequent years, the net cost savings rises to $14.04 per person per year.

Indirect benefits. Avoidance of morbidity and mortality and their attendant costs is an indirect benefit of hip fracture prevention. Indirect cost savings were estimated using the willingness to pay method of valuing avoided mortality and morbidity as outlined by Viscusi [37], who reported lower range valuations of $600,000 to avoid death and $13,810 to avoid injury. Using the full consumer price index, the following adjusted year 2000 dollar values were obtained: $715,432.50 to avoid death and $16,466.80 to avoid injury.

The case-fatality rate for hip fracture patients within 1 year following the injury is approximately 24% but varies from 14% to 36% [38–42]. Given that 0.49875 hip fractures per year are prevented with the intervention, then it is possible that 0.49875 × 0.24 = 0.1197 deaths will be averted with the tai

Table 2. Hip Fracture Costs*

Source	Mean Charge, $	2000 Charge, $	2000 Cost, $
Hospital payments			
HCUP 1996 (fracture—neck of femur) [20]	16,747	18,992.65	11,015.74
	25th percentile, 9927	(10,838)	
	75th percentile, 19,539	(21,456.79)	
HCUP 1997 (DRG 210) [21]	17,294 (Medicare)	19,077.95	11,065.21
	17,824 (all payers aged 65–84)	(19,134.42)	
	16,735 (all payers aged 85+)	(17,965.36)	
Ernst and Young 1999 (DRG 210) [22]	18,225 (all payers)	18,821.35	10,916.38
	25th percentile, 11,453	(11,844.85)	
	75th percentile, 20,694	(20,680)	
National Long Term Care Survey (1994 data) [23]	11,900 (Medicare)	14,595.83	
Schenck et al (1997 data) [24]	14,029 (Medicare)	15,476.15	
Beck et al (1994 data) [25]	16,072 (not counting physician fees)	19,712.96	11,433.51
Ray et al (1995 data) [2]	17,870	20,974.11	12,164.98
Autier et al (1996 data) [26]	10,768 (direct costs)	12,211.91	
Nursing home payments†			
National Long Term Care Survey (1994 data) [23]	5900 (direct costs)	7581.00	

*Year 2000 charges and costs derived from medical component consumer price index adjustment are displayed in parentheses.

†Includes Medicare part B physician payments, other part B items (eg, durable medical equipment and rehospitalizations in first 6 months post–hip fracture).

chi intervention. Otherwise stated, 1 death will be averted after approximately 835 patient years of tai chi, at a cost of between $64,294 and $66,694, assuming 2 to 4 new assistants are trained during this time period. The value of mortality avoided utilizing the willingness to pay estimates is $0.1197 \times \$715,432.50$ or $85,637.27 for the cohort, or $856.37 per person per year.

Approximately 5% of falls result in fractures [35]. Although an additional 5% of falls result in soft tissue injury, these will not be considered in the morbidity analysis due to the wide range in severity. Assuming 49.875 fewer falls per 100 participants in the setting of tai chi, and using fractures as an indicator of morbidity, substantial morbidity will be avoided in $49.875 \times 5\% = 2.49$ patients per year. The value of morbidity avoided utilizing the willingness to pay estimates is $2.49 \times \$16,466.80 = \$41,002.33$ or $410.02 per person per year.

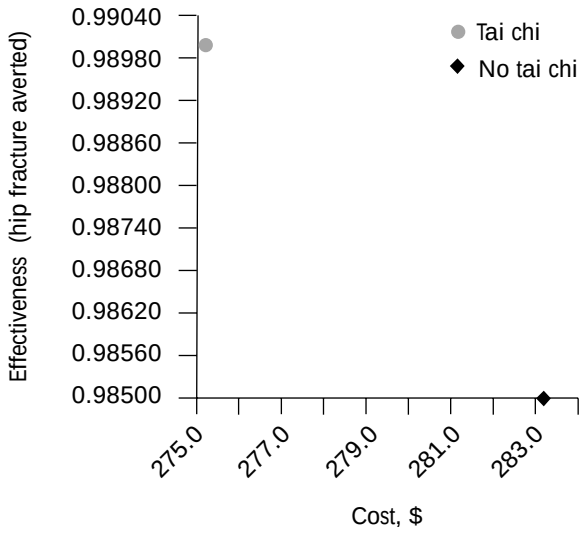

Figure 2. Cost-effectiveness analysis of tai chi intervention.

Total benefits. The total net benefit of the tai chi intervention is calculated to be $1274.43 per person per year. The results are summarized in Table 1. The cost per fall averted ($172.68) and cost per hip fracture averted ($17268.17) can be compared to the total direct costs of hip fracture ($18,881) and to published estimates of direct costs per fall. Rice et al [43] derived a cost of $3443 per fall in 1985 dollars ($7622.95 in year 2000 dollars) for individuals aged 65 years and older using a series of 1980–1982 surveys conducted by a firm under contract to the National Center for Health Care Statistics. Rice et al included expenditures for emergency room, hospital and nursing home care, physician and other professional services, rehabilitation, community-based

Table 3. Values Used in Sensitivity Analyses

Annual cost of tai chi intervention per person	$86.13 ($53.63 – $118.63)
Direct cost of hip fracture (hospital fees + 6-month SNF costs)	$18,881 ($16,381 – $22,981)
Average number of falls per resident per year	1.5 (1.45 – 2.08)
Relative risk of fall with tai chi	0.525 (0.321 – 0.86)
% of falls that result in hip fracture	1% (0.5% – 2.0%)
Probability of hip fracture with tai chi	0.007875 (0.0035943 – 0.025388)
Probability of hip fracture without tai chi	0.015 (0.00725 – 0.0416)
Probability of noncompliance	0.3 (0.1 – 0.5)
1-year mortality from hip fracture	24% (14% – 36%)

SNF = skilled nursing facility.

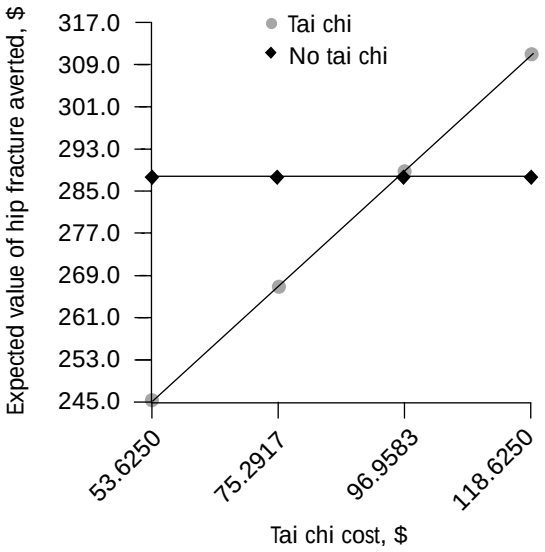

Figure 3. Sensitivity analysis on tai chi intervention cost. Threshold values: tai chi = 95.603; expected value = $287.5/hip fracture averted.

services, drugs and medical equipment, insurance administration, vocational rehabilitation, and home modifications. Given that this figure is derived from both community dwelling and institutionalized elders, it is understood that this cost likely overestimates the true cost per fall in the nursing home residents that serve as the target population for the tai chi intervention. Even so, one can see that the estimated cost per fall far exceeds the cost per fall prevented in the presence of the tai chi intervention, hence tai chi stands to be far more cost saving than is suggested by using hip fracture costs alone.

Sensitivity Analysis

To maximize the internal validity of the decision model, sensitivity analyses were conducted on all variables for which there was a degree of uncertainty. These variables and their ranges are displayed in **Table 3**. Sensitivity analysis was performed around the estimates for fall rate on the presumption that increasing familiarity with the program will result in a shifting pattern of average fall risk among current practitioners.

The sensitivity analysis allowed determination of cutoff points beyond which the intervention was no longer cost saving when direct costs alone were considered. The intervention was no longer cost saving beyond a price of $95 per person, as displayed in **Figure 3**. Another way to express the price cutoff is to consider that those organizing the tai chi intervention would need to recruit 91 patients instead of 100 for the intervention to continue to be cost saving. With respect to the uncertainty around the cost of hip fractures, tai chi was not cost saving when the hospital plus 6-month incremental skilled nursing facility costs of hip fracture care were less than $17,268.17. Of note, this value falls within the margin of uncertainty obtained by the literature review and consumer price index adjustments.

The level of sensitivity of the decision tree to each variable is represented by a tornado diagram (**Figure 4**) in which each sensitivity analysis results in a single horizontal bar representing the range of possible outcomes. The bars are arranged from top to bottom with the widest bars at the top indicating the variables to which the output is most sensitive. According to this diagram, the decision tree is most sensitive to changes in the probability of hip fracture in the absence of tai chi or with noncompliance (0.00725 to 0.0416). The probability of a hip fracture even after taking tai chi (0.0035943 to 0.025388) is also a relatively sensitive variable. The wide variation in these probabilities stems from the fact that they incorporate the uncertainty of separate variables; that is, average fall risk, relative risk of falls with tai chi, and probability of hip fracture given fall. Of note, the intervention was no longer cost saving when the relative risk of falls in tai chi recipients as opposed to nonrecipients exceeded 0.56557. This is only marginally higher than the relative risk of 0.525 reported by Wolf et al [9]. Finally, it was determined that tai chi did not produce net cost savings in the event of greater than 104 falls in tai chi recipients in comparison to the expected 150 falls in the absence of tai chi. It should be kept in mind, however, that these narrow margins are the result of performing calculations with consideration to direct costs

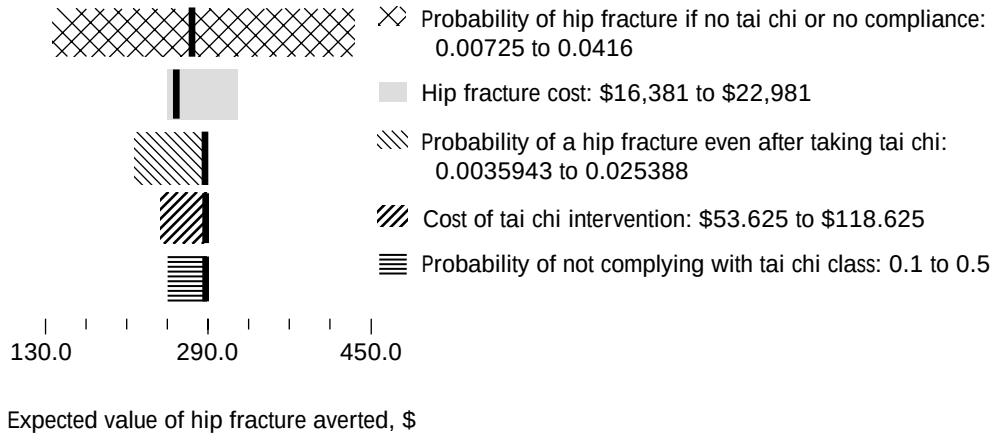

Figure 4. Tornado diagram of variables used in sensitivity analysis.

of hip fractures averted only, and incorporate neither indirect hip fracture costs nor other direct fall-related costs.

Discussion

The present cost-benefit analysis provides support for the institution of a tai chi intervention for fall prevention in nursing home residents of average fall risk. This conclusion is based on the finding that the benefits of the tai chi program, ie, direct and/or indirect costs avoided, exceed its costs. As opposed to a cost-effectiveness analysis, the cost-benefit analysis expresses both costs and benefits in dollar terms and does not provide an estimate of benefits in terms of quality-adjusted life years. Rather than obtaining cost per life year gained, the calculations produce a cost per life saved, which is compared to willingness to pay to avoid mortality. Given the number of assumptions employed in the analysis and the fact that the relative risk for falls with tai chi is derived from a single study, it was decided not to incorporate Markov modeling into the analysis to compare the life expectancies of the subjects participating in the alternate strategies.

By restricting the cost assessment to hip fracture costs only, it is apparent that the true benefits of the tai chi program are significantly underestimated. For example, in the present analysis, tai chi was no longer cost saving when the intervention cost more than $95 per participant and thus might not be considered to be favorable in all geographic areas based on the aforementioned instructor fee estimates. Indeed, the cost savings reported in the present study are likely to be more favorable if additional fall-related costs (eg, emergency room visits, ambulance fees, durable medical equipment, medications) are considered. While nursing home residents who return to the nursing home after a hip fracture require a higher level of care [30], previously independent patients admitted to a skilled nursing facility cost more than those who are readmitted to nursing homes [44]. Many of the available cost estimates do not take these differential factors into account. This may explain why Ray et al and Cummings et al [2,45] calculate per patient hip fracture expenditures at $32,428 and $29,800, respectively. In addition, French et al [44] demonstrated that average cost methods determined by multiplying the average orthopedic bed day cost and multiplying it by the average number of inpatient days overestimate the cost of hip fracture care by 23% for acute care and as much as 92% for rehabilitation services. Studies utilizing such methods of cost derivation were not considered in the present analysis.

An additional consideration that may lead to an underestimation of the true benefits of the tai chi intervention is the decision to negate any beneficial effects in the event of noncompliance. Despite the conservative estimate of fall risk reduction resulting from consideration of noncompliance, it is noted that tai chi remained cost-beneficial in comparison to the option "no tai chi" when subjected to sensitivity analysis at a range of 10% to 50% noncompliance. In addition, the tornado diagram reveals that the model was less sensitive to variation in compliance than to variation in other variables.

The utilization of "willingness to pay" as a monetary estimate of the intervention benefits has been questioned by some authorities in the health economics arena [46] as it favors the wealthy over the poor. Until side-by-side economic analyses are performed that allow derivation of quality-adjusted life years for the purposes of cost-effectiveness analysis, cost-benefit analysis represents the best estimate of

the economic impact of a tai chi intervention given the available literature. In incorporating the literature-based [37] willingness to pay estimates for morbidity and mortality averted, it is recognized that these estimates are generic rather than disease-specific and thus may have inherent biases. For this reason, emphasis was placed on the importance of net cost savings when direct benefits only were considered.

It is acknowledged that the foundation for the present analysis is essentially limited to a single study [9] evaluating the effect of tai chi on the relative risk of falls. Subjects in the study were recruited from unsupervised environments, were independent with respect to activities of daily living, and were subject to strict exclusion criteria. Patients were excluded in the presence of severe cognitive impairments, metastatic cancer, crippling arthritis, Parkinson's disease, major stroke, or profound visual deficits that could compromise balance or ambulation. While the stringent exclusion criteria does limit the generalizability of the study, the present model considers an intervention directed at residents at average risk rather than at high risk for falls, and incorporating the confidence intervals of the study results in the sensitivity analysis addresses external validity to the extent possible. Despite these considerations, it is still conceded that the translation of the findings by Wolf et al [9] to a retirement community with a wider range of functional limitations may not produce an equivalent relative risk reduction. Of particular note, although cost savings were seen when the relative risk of falls in the tai chi group was identical to that seen in the study by Wolf et al [9] (ie, 0.525), cost savings were not seen at a relative risk of 0.56557 or more. This suggests that there is a narrow margin for error in duplicating the effectiveness of Wolf et al [9] in a different population. One must consider, however, that the purpose of the present analysis was to determine whether tai chi could prove cost saving in the setting of a restricted analysis (ie, consideration of hip fracture costs averted only). Analysis of other fall-related costs would most likely shift the cutoff point for relative risk upward. As such, the future generation of detailed cost per fall information for nursing home and retirement community residents will facilitate a more detailed economic analysis.

In conclusion, the cost-benefit analysis described above highlights tai chi as an economically feasible intervention among elderly nursing home residents of average fall risk when viewed from a societal perspective. The analysis revealed tai chi to be moderately cost saving within this time period when direct benefits alone were considered. When direct plus indirect benefits are considered, the intervention produces a more favorable net benefit. The economic advantages of tai chi stem from its ability to reduce fall risk. The disadvantages of tai chi include a reliance on patient compliance and the necessity to provide the intervention to a large number of elderly nursing home residents in order to produce the beneficial effects. Despite the economically favorable analysis, further utility studies of tai chi interventions within a nursing home environment are required to confirm that the results of Wolf et al [9] translate to a more frail population with a higher baseline fall risk.

In addition, while tai chi was found to be feasible from a societal perspective, it is apparent that nursing homes may incur the costs of such a program, whereas Medicaid, Medicare, and other insurance carriers may see the financial benefits. As such, it may behoove insurance carriers to reimburse for such an intervention should further studies of the utility and effectiveness of tai chi in a nursing home population prove supportive.

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