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Economic Analysis of Tai Chi as a Means of Preventing Falls and Falls Related Injuries Among Older Adults

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EXECUTIVE SUMMARY

This study has examined the costs and consequences of a randomised controlled trial of a community based Tai Chi program for people over 60 years of age. The hypothesis for the trial was that compared to non-participants, participants in the Tai Chi program would have fewer falls and may experience additional health and other benefits. In terms of resource use it was anticipated that the Tai Chi program would use additional resources in terms of running costs but was expected to save resources as a result of falls prevented. Data for this economic evaluation were collected prospectively alongside the randomised controlled trial.

AIMS

The aim of this evaluation was to investigate the cost-effectiveness of Tai Chi as means of preventing falls in elderly people living in the community.

METHODS

Costs included were those of the Tai Chi trial and health service utilisation (including GP and specialist and other consultations, tests, hospitalisations and medications).

Effectiveness was measured as the number of participants in the intervention and control groups, all participants and the number of falls avoided.

SPSS was used to analyse the data; Fisher's exact and the student's t-test were used to test differences between the intervention and control groups.

RESULTS AND CONCLUSIONS

From the perspective of NSW Health, the cost of providing Tai Chi as part of this trial ($81232) outweighed any costs of health service provision ($24795). Only a small proportion used health services and this mostly involved the use of over-the-counter pain relieving medication and GP consultations. Only 3 people were admitted to hospital. There were no significant differences between the study and control groups in terms of utilisation and costs except in terms of overall costs where the control group costs were significantly more than the study group (p=0.43). However, this difference was driven by the cost of one admission to hospital.

In the trial 3/216 falls resulted in hospitalisation. This means that for every 100 falls avoided, 1.4 serious falls were prevented. Assuming that Tai Chi would continue to prevent falls at the same rate as the trial, 740 individuals would need to participate in Tai Chi to avoid 100 falls and 1.4 serious falls. The value of avoiding a small number of serious falls must be weighed against the high cost of treating and managing the consequences of such falls.

BACKGROUND

A randomised controlled community trial of Tai Chi classes was conducted in 2002 amongst community dwelling older people aged over 65 living in the Central Sydney Area Health Service. Subjects were randomly allocated to either an initial-intervention group or a waiting-list control group. The intervention consisted of 16 weeks of Tai Chi classes (1 class per week). The control group will be given Tai Chi classes after the initial 16-week period.

Exclusion criteria included individuals with neurological disease (such as Parkinson's or stroke), metastatic cancer, severe arthritis or who cannot walk across a room independently or with a cane. In addition, people with dementia, cardiovascular disease and who take medications known to impair balance were also excluded.

A pilot study conducted by the CSAHS HPU in 1999 (HPU, 1999) indicated that a very effective way of reaching the target population is through a social marketing campaign using local and community newspapers. Classes will be free initially (5 week period), after which participants will be pay a minimal fee of around $4 per class. Informed consent procedures were used to explain that participants would be required to complete physiological tests and questionnaires at pre-intervention and at post-intervention, as well as record daily falls over a minimum of 6 months.

An economic evaluation was undertaken in conjunction with the trial of Tai Chi. This CHERE Working Paper reports the results of the economic analysis of the trial.

AIMS

To produce from the perspective of NSW Health:

- An economic evaluation of Tai Chi compared with no Tai Chi in preventing falls for elderly people living in the community.

General approach

Economic approaches to program evaluation aim to compare alternative courses of action in terms of both their costs and their consequences. The two key concepts that guide the methods of economic evaluation are:

- Marginal analysis – i.e. what are the additional (rather than average) benefits, costs or savings achieved by following one course of action rather than another.
- Opportunity cost – i.e. wherever possible, resources (or money) used are valued according the value of the benefits which could have arisen had they been applied to their 'best alternative use'.

Trying to apply these principles in turn requires health economists to be explicit about the "perspective" of the analysis: essentially, whose costs are we interested in, and whose benefits? While the societal perspective is seen by health economists as the most desirable, (Gold et al. 1996) arguments can be made for the use of a narrower perspective. In this study, the question of interest pertains to the use of health care system resources and therefore this is the appropriate perspective to take.
Also, in order to be reproducible and amenable to comparison with other evaluations of health programs health economists strive to provide separate estimates regarding the quantity of resources consumed (e.g. General Practitioner consultations, hospitalisations),

and the valuation (or units costs) of the different types of resource needed for each alternative. Thus, any results presented will aim to quantify and value any resources used, and any health benefits generated, in the same way and to an equivalent level of detail for each of the alternatives evaluated. If the results rely on certain key assumptions those assumptions will be varied to assess their effect of the final result (i.e. a 'sensitivity analysis' should be carried out: for example, cost assumptions might be varied to reflect changes in the rate of GP consultations, hospitalisations or the cost of Tai Chi classes).

In summary, a systematic approach to economic evaluation ensures that:

- the viewpoint or perspective of the evaluation is specifically stated.
- the relevant alternatives are clearly identified; and
- the relevant consequences and resources are identified, measured and valued.

METHOD

Perspective

The perspective taken was that of the health system (in this case, the NSW Department of Health). Taking this perspective will maximise the transferability of the results, providing information which will enable decision makers in other health systems and Area Health Services to assess the extent to which the results will be applicable to their population.

Definition of the alternatives to be compared

In this evaluation, the alternatives were:

- The Tai Chi program: Individuals randomised to this arm of the trial were offered the opportunity to attend a course of 16 Tai Chi classes in their local area.
- No intervention: individuals randomised to this arm of the trial were placed on a waiting list for Tai Chi classes scheduled to commence once the Intervention group classes were complete.

All the costs and consequences to individuals were identified and those which pertained to the NSW Health system were measured and valued. Although participants incurred out-of-pocket costs such as co-payments for health services and private health insurance premiums, as these are likely to vary widely in different health systems and services, they have not been included in the measurement and valuation of resource use.

Assessment of costs

The approach adopted for this study identifies and measures individuals' utilisation of health care services but applies a standard cost (or price) such as Medical Benefit Schedule (MBS) fees, AN-DRG cost data for hospitalisations, and available fee schedules for ancillary care to value the resources used. This method was chosen to provide results that are generalisable to other areas with similar populations where the cost structure may be somewhat different to that of Central Sydney Area Health Service.

Participants in the trial completed a health care use diary, which was provided monthly together with a falls calendar. Participants were instructed to complete the falls calendar every month but to complete the health care use diary only when a fall occurred. The diary contained categories (such as doctor visits, hospital stay, and name of hospital) for completion. Participants were requested to return the diary with the monthly falls calendar. During the follow-up interview following a fall, any necessary information

regarding the fall or utilisation of health services was clarified. During this telephone contact, the participant was asked to sign a consent form enabling the research team to contact any hospital at which they were treated as a result of the fall. This allowed more accurate costing of any hospital episode.

It is important to note that the additional information that was sought from the participants' health care providers only occurred with the informed consent of individual participants. Where it was unclear whether health services were utilised as a direct result of a fall, a review committee determined the final decision.

An inventory of the health services which were utilised and sources of data are presented in Table 1. The use of average costs ensures transferability of the study results across a variety of settings. For example, average costs for given DRGs, PBS data, and MBS schedules.

The other cost considered was the cost of the Tai Chi classes themselves. The components of this cost included the cost of venues, the cost of advertising and the cost per course of 16 classes.

Table 1: Sources of Health Care Resources

	Source of Resource Use		Source of Cost Information	Cost
Resource	Participant/ family	Hospitals		
Doctor contact	✓		MBS schedule	$25.05 (GP); $30.35 - $60.45 (specialist)
Radiology	✓		MBS schedule	$21.05-$74.943
Pathology	✓		Manual of resource items1 AAC 104	$25
Physio	✓		Manual of resource items1 AAC 96	$33
Alternative therapies	✓		Manual of resource items1 AAC 96	$33
ED visit	✓	✓	Manual of resource items1 AAC 12	$29
Public Hospital –LOS/DRG	✓	✓	AN-DRG average costs	As per individual AR-DRG costs
Private Hospital – LOS/DRG	✓	✓	DRG costs	As per individual AR-DRG costs
Medications	✓		PBS schedule/patient2	Panadol $4.45 Panadeine $5.50 Panadeine Forte $12.45 Neurofen $5.90 Naprosyn $14.25 Vioxx $23.70 Orudis $39.25 Voltaren Gel $15.75 Digesic $6.95 Tetanus injection $18.82 Cortsione injection $35.56

1 Australian Department of Health and Ageing. 2002 Manual of resource items and their associated costs.
2 PBS used for the Cortisone and Tetanus injections; RRP of mid-size packet of each OOC medication used.
3 MBS individual items used. 75% rebate used (ie all tests performed in hospital).

Assessment of effectiveness

In this evaluation, the end points chosen were those deemed to be most useful to policy and decision makers within the health system. Thus, outputs such as the number of participants in each group as well as an intermediate outcome, the number of falls avoided, were measured. These measures have the advantage of being easily understood and may be more useful from a health service perspective than longer term outcomes such as the number of lives or life-years saved.

Analysis

All data were entered into Excel. SPSS was used to analyse the data; Fisher's exact and the student's t-test were used to test differences between the intervention and control groups.

Sensitivity analysis

As well as estimating the average cost effectiveness of the intervention, sensitivity analyses were conducted on key economic inputs, including the average cost of the Tai Chi classes and the number of hospitalisations.

RESULTS

The cost of Tai Chi

The cost of Tai Chi classes includes the cost of a venue, the cost of an instructor and the cost of advertising the classes. The costs below have been estimated using information from the trial for a total of 48 classes which were provided for the intervention group. Although the cost of hiring a venue and an instructor may not vary, for established classes, the cost of advertising may drop and thus the annual running costs of a program of Tai Chi for elderly people may be much lower than that indicated in Table 2. This issue is explored further in the sensitivity analysis.

Table 2: Costs of Tai Chi classes

Cost component	**Unit cost**	**Total cost**
Venue hire	Av cost/venue = $156	$7488
Instructor	Cost per course = $800	$38,400
Advertising	Av cost/cohort = $736.34	$35,344
TOTAL COST		$81,232

Health service utilisation and cost

The total number of individuals who fell was 155 (72 I; 84 C) and the total number of falls amongst all trial participants was 217. The total number of individuals who used health care services following a fall was 37 (20 I; 17 C) and the total number of falls which resulted in health care use was 46 (24 I; 22 C).

Table 3: Number of falls and related resource use

	Control		**Intervention**	
# falls	**Freq.**	**Health care use**	**Freq.**	**Health care use**
0	253	n/a	275	n/a
1	56	10	57	16
2	15	5	15	4
3	10	1	0	-
4	1	1	0	-
5	2	-	0	-
Total falls	**130 (84 individuals)**	**17**	**87 (72 individuals)**	**20**

Whilst the rate of falls (i.e. the number of falls divided by the number of participants) was significantly lower in the Intervention group than the Control group (25% vs 39%; p=0.05), the rate of falling (ie the number of individuals who feel at least once divided by the number of participants) was very similar (10% I; 12% C). The rate of health care utilisation was significantly higher in the Intervention group: 24% (21/87) of falls in the Intervention group resulted in health care utilisation compared with 14% (18/130) in the

Control group (p=0.003). Overall, 2.6% of the Intervention group used health care resources compared with 2.4% of the Control group.

Table 4: Type of utilisation of health services

	GP	Specialist	Tests	ED	Hospital adm	Physio/ Chiro	Alt. therapy	Medication
Control	20	2	6	0	1	6	23	8
Intervention	19	5	13	6	2	7	2	15

Overall, the number of services used was small, reflecting a relatively healthy population. Some of the numbers in Table 4 reflect the utilisation of services by one or two individuals. For example, one individual in the Control group used 22 of the 23 alternative therapy services (16 hydrotherapy sessions and 6 acupuncture sessions). Apart from this, it can be seen that consultations with GPs, physiotherapists and chiropractors were almost identical for the Intervention and Control groups and that only a small number of specialist visits were made. Of the 19 tests ordered, 18 were either X-rays or Ultrasound examinations. Most medications used were over-the-counter medications for pain-relief or reduction of inflammation. One person had a cortisone injection and one a tetanus injection (both members of the Intervention group).

In terms of hospital resources used, all emergency department attendances and two of the three admissions were to public hospitals. One person attended the emergency department on two occasions. Two of the six visits to the emergency department resulted in admissions to hospital and one person was admitted to a private hospital without prior attendance at the emergency department.

In most instances, there was no significant difference between the groups in terms of utilisation. Table 5 shows that the only significant differences in utilisation were in the number of pathology or radiology tests (p=0.0031) and the number of occasions when alternative therapies were used (p=0.0000).

Table 5: Comparison of health care utilization by trial participants

	Proportion of participants using services		
	Intervention n=347	**Control n=337**	**P***
Any service/s	25	22	0.4185
GP	5.4	6.5	0.63
ED	1.7	0.3	0.1234
Admissions	0.6	0.3	1.0
Medication	7.8	4.7	0.1160
Tests	6.3	1.7	0.0031**
Specialist	0.86	0.89	1.0
Physio/chiro	1.73	0.89	0.5053
Alternative therapies	0.58	6.8	0.0000**

*All p-values by Fisher's Exact test

Despite the fact that there were few differences between the study groups in terms of utilization of services, Table 6 shows that for all categories of costs except GP services, the intervention group incurred significantly higher costs than the control group.

Table 6: Average cost of services used by trial participants

	Intervention n=347	**Control n=337**	**Difference in mean I-C (95%CI)**	**P***
Total cost Mean	$18,914.98 $54.51	$5880.25 $17.45	 $37.06 ($0.06-$0.15)	0.0000**
GP cost Mean	$475.95 $1.37	$551.10 $1.64	 $-0.27 (-$0.02-$0.14)	0.8595
ED cost Mean	$174.00 $0.50	$29.00 $0.09	 $0.41 ($.035-$0.47)	0.0000**
Admission cost Mean	$16,805 $38.45	$3,872 $11.49	 $26.96 ($0.38-$11.69)	0.0001**
Medication cost Mean	$230.38 $0.66	$101.25 $0.03	 $0.63 ($0.57-$0.68)	0.0000**
Tests cost Mean	$654.70 $1.89	$249 $0.74	 $1.17 ($0.67-$0.77)	0.0000**
Specialist cost Mean	$211.95 $0.61	$120.90 $0.36	 $0.25 ($-0.32-$-0.18	0.0000**
Physio/chiro cost Mean	$297 $0.86	$198 $0.59	 $0.27 ($0.20-$0.33)	0.0000**
Alternative therapy cost Mean	$759 $2.19	$66 $0.20	 $1.99 ($0.14-$0.23)	0.0000**

*All p-values by t-test
** significant at 5% level

SENSITIVITY ANALYSIS

Health service utilisation

As small proportions of each group used health care resources, overall, these represent a relatively insignificant aspect of the costs of the trial. However, resources used due to admission to hospital represented 67% of Control group costs and 89% of Intervention group health care costs and involved only three individuals. Given the potential for falls to be serious and therefore to result in expensive hospitalisations, it is pertinent to examine how many participants would be required to reduce serious falls by a significant number. In this trial, 3/216 falls resulted in hospitalisation. In other words, for every 100 falls avoided, 1.4 serious falls were avoided. Assuming that participation in Tai Chi resulted in the same rate of fall avoidance as occurred here, 740 people would need to take part in classes to avoid 100 falls and 1.4 serious falls.

The costs of Tai Chi

In this study, participants were charged $44 per course of 16 Tai Chi classes. If this amount is used to offset the costs of Tai Chi, the total cost of Tai Chi to the government

is reduced to $65964. In turn, the average costs per Intervention group member, per participant and per fall avoided are also reduced to $245, $227 and $1683 respectively (see Table 7 below).

It could also be argued that the costs of the Tai Chi program as it was organised for the purposes of the trial, do not accurately reflect the costs of a similar program provided by a community or commercial organisation. For example, because of the need to enrol a large number of participants in the trial, the advertising costs were higher than would be the case for ongoing Tai Chi programs. Tai Chi classes are commonly provided by non-profit community organisations and the prices charged for such classes have been used to estimate more realistic costs of providing Tai Chi. For example, if all 684 participants continued Tai Chi for one additional course of 16 lessons, and the price per course was raised to $60 (2005 fees, as supplied by the non-profit community organisation) the cost will be $41,040. If these costs were met by the participants in the Tai Chi classes, the provision of Tai Chi would, from the perspective of the government, cost $60 per participant and $444 per fall avoided (see Table, below).

Table 7: Sensitivity analysis

	Costs offset by charging $44 per course to members of intervention group	**Costs offset by charging $60 per course for 684 participants.**
Intervention group	$245	n/a
Control group	$17	n/a
Participant	$227	$60
Fall avoided	$1683	$444

DISCUSSION

It is becoming increasingly well-established that a number of exercise-related interventions are effective in preventing falls among elderly (Gardner et al, 2000, Gillespie et al 2002,). However, less is known about their effectiveness in preventing falls-related injuries or the cost-effectiveness of interventions (Gillespie et al, 2002), although one New Zealand study has shown no significant differences in health service costs between groups of elderly women randomised to receive either an exercise program or usual care and social visits (Robertson et al, 2001). Although the number of published studies is small, Tai Chi has been shown to significantly reduce both falls and injurious falls (Fuzhong et al, 2004).

In this study, where the important resources to capture are those of the intervention itself (the Tai Chi program) and any health care savings that may be attributed to the Tai Chi program, health service use and costs related to falls in both the control and intervention group were documented. It was expected that approximately 24% of the control group would fall compared with approximately 14% of the study group. Although the rate of serious falls or use of health services was not predicted it was recognised that those falls that result in a serious injury may incur significant health system resource use. For example, published literature has found hip fractures to be a costly consequence of a fall resulting in increased medical and nursing home costs for the patient. Randell et al. (1995) estimated the total cost of osteoporotic fractures to the Australian community in 1992 to be $779 million. Fall prevention strategies, such as Tai Chi, may have the potential to reduce this cost.

A higher rate of falls than predicted was experienced by both intervention (25%) and control (39%) groups. However, only a small proportion of falls resulted in use of health care resources. Even though the rate of falls was lower in the Intervention group, this group used more health care resources, although the differences were largely driven by the costs of hospital care, which was incurred by three individuals only. Hospital care represented 67% of the costs for the Control group and 89% of those incurred by members of the Intervention group. If these costs are removed, the total costs for each group are similar ($2008 C; $2110 I). Overall, this represents a relatively small amount of resources and is dwarfed by the costs of the Tai Chi program ($81232). This cost, in turn, drives the average cost of the intervention group (which is significantly higher than the average cost for the control group) and the average cost per fall avoided.

However, the cost of Tai Chi in this trial situation was higher than would be expected if a similar program was provided by a community organisation due mainly to higher advertising costs required to recruit large numbers of individuals in a relatively short space of time. If the true costs of providing Tai Chi reflect the costs incurred by the community organisation which has continued the classes set up for the purposes of the trial, then Tai Chi for this group of elderly will cost $60 per participant and $444 per fall avoided.

The study has provided useful information not only about how often healthy elderly people fall, but the extent to which they are able to cope with falling. Whilst the rate of falls was not unexpected, the lack of utilisation of health care may not have been expected. Even when health care was accessed by those who fell, it typically involved relatively minor use such as a consultation with a GP and/or use of pain relieving medication. It is reassuring to note that most people were able to manage a fall well.

The major limitation of the study of resource use among this population was the reliance on self-reporting of falls and utilisation of health care. However, all reported falls (whether by diary or verbal communication) were followed up with the individual concerned. Whilst the accuracy of the data cannot be independently verified, traumatic events such as falls and the subsequent use of health care are likely to be well recalled. Even where exact data were difficult to obtain (eg the use of over-the-counter medications) a conservative method of estimating costs was employed which is likely to result in an over-estimation of these costs.

This study has adopted the perspective of the health system in the assessment of costs of Tai Chi in preventing falls. Additional costs to individuals and society which were not counted included co-payments for health services such as GP and specialist consultations and pharmaceuticals, gap payments for hospital admissions if the individual was admitted as a private patient and private health insurance premiums. A final complicating factor which has also not been taken into account is that a number of individuals attended the Tai Chi classes even though they were not participating in the study, paying $66 per course.

CONCLUSION

Although it seems unlikely that health promotion resources in the form of Tai Chi classes directed at this group of elderly will have a significant impact on reducing serious falls (ie those which result in high levels of health care resource use), the value of avoiding a small number of serious falls must be weighed against the high cost of treating and managing the consequences of such falls.

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