

2014 International Tai Chi Chuan Symposium

LITERATURE REVIEW: COGNITIVE DEFICIT, ALZHEIMER'S DISEASE AND VASCULAR DEMENTIA. TAI CHI CHUAN BASED RESEARCH.

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1-INTRODUCTION

The cognitive process could be considered, as all that behavior modification should make every living to adapt and manage in an environment effectively.

Sensorimotor interaction with the environment has become the mainstay in the study gives cognition (1)(2)(3), leaving the brain, in the midst of this dynamic such as integrating body and convergence.

The brain and nervous system is an autonomous dynamic system that actively generates and maintains its own coherent and meaningful patterns of activity, according to its operation as a circular and reentrant network of interacting neurons (4).

The normal elder and certain neuropsychiatric diseases, suffer cognitive impairment. In these cases, magnetic resonance shows brain injury.

From Boobath, the concept that the brain has ability to reorganize, which means that the healthy parts of the brain learn in certain circumstances and can compensate functions that were previously performed by the damaged brain regions. The prerequisite for this is, however, a stimulus applied to the patient.

Currently all these prevention and treatment of cognitive processes base on neuronal plasticity (5). Neural plasticity is the ability to adapt the nervous system and its ability to modify its own structural and functional organization (6)(7)(8) .

This neural plasticity is a key for functional recovery and focus in the recuperation. Plastic adaptation of the nervous system occurs in response to internal changes and external environment changes, learning and experience. The remodeling occurs at molecular and cellular level. Are given short-term changes that involve changes in presynaptic efficiency (9) (10), while medium-term changes relate to the post-synaptic membrane. It could be changes in gene expression of the cell but evolve long term (11).

The interaction between form (neuromuscular system anatomy) and function (behavior strategy used to perform a task) influences remodeling. Neural plasticity may cause compensatory motor behavior, or may lead to the development of alternative methods for acquiring normal function (12).

From these experiences is now considered in brain pathologies, therapeutic exercises and mind - body exercises mainly with the addition of drugs, a multimodal treatment as a most promising therapy.

The Tai Chi Chuan (TCC) would be the ideal mind-body exercise, because stimulates:

- *attention
- *concentration
- *memorization
- *has physical activity and
- *neuromuscular sensory stimulation

The application of TCC is extremely wide in the area of medicine, but the group that conducted this review focused on a cluster of diseases involving cognitive impairment, in agreement with the coordination of the symposium, and they are: mild cognitive impairment, Alzheimer's disease and vascular dementia.

1.1. Mild Cognitive Impairment

In a brief definition, mild cognitive impairment, includes the presence of subjective memory complaints with objective evidence related difficulties but with conservation of general cognitive functions and no signs of abnormal activities of daily life to prevent an independent life, that is, in essence, is an alteration of memory without any dementia (*American Psychiatric Association 2000(13)(14)(15)(16)*).

1.2. Alzheimer's Disease

It can briefly define Alzheimer's disease, as a progressive and irreversible neurological disorder that affects the brain causing death of neurons. Is the most common of all dementias, producing a deterioration of cognitive functions (*NINCDS-ADRDI & American Association of Psychiatry 2007(17)*). The most common initial symptoms include loss of memory recent things (you forget what you just said, what just happened, etc.), loss of concentrating ability, the interest in things, tendency to isolation and disorientation. In a next phase cannot understand simple instructions, at home becomes irritable, isolated; behavioral problems may arise, such as aggression or screaming can hide things or accuse others. In the final phase the patient is unable to walk (and makes the life of the bed to chair), has incontinence of sphincters and goes almost completely disconnecting the surrounding environment, leading a life almost vegetative.

1.3. Vascular Dementia

It could be defined the vascular dementia and functional impairment that occurs in the brain due to lesions from insufficient blood supply (*NINDS-AIREN criteria for diagnostic of vascular dementia 2003(18)*).

The term "vascular dementia" includes various dementia syndromes associated with a variety of cerebrovascular lesions. There are three main types of vascular dementia:

- 1 -cortical dementia, also called multi-infarct dementia
- 2-Subcortical dementia, also known as dementia due to involvement of the small vessels
- 3-Infarct dementia by strategic location of lesion

The concept of vascular dementia was proposed in 1896 when Emil Kraepelin described as arteriosclerotic dementia".

There is a third group called mixed dementia that develops Alzheimer's disease with involvement of the vascular supply.

In recent years, it has tried to insert the TCC as preventive and therapeutic purposes in this group of patients, but these are still isolated efforts.

Most scientists, and even patients and their families still observe the TCC as a hobby or as a chance to socialize and continue watching with suspicion the results.

From these working groups have been published papers and articles.

To know the current situation, this review analyze these papers, also trying to inspire towards a path of research where evidence that TCC provides clear health benefits, and making the distrust of scientists at confidence.

2. PURPOSE

The current critical review was an overview of relevant timed –dated research from January 2009 to June 2013. It is further limited to reports of studies available as full text.

Research questions included:

1. How has the research grown over the last years?
2. How global is the research interest?
3. Tai Chi Chuan used as a treatment in degenerative mental disease.
4. Their effects have been investigated in these clinical areas?
4. What is the strength of evidence under study?
5. There are recommendations to apply in future research?

3. METHODS

In June 2013, we performed a bases search including MEDLINE and PUBMED CINAHL, EMBASES, RECAL, SPORTDISCUS, Cochrane Library, AMED and APOS using as key words :*Tai Chi; Taiji; T'ai Chi; cognitive impairment, dementia, Alzheimer's, vascular, randomized controlled trial; clinical Trial*. In addition titles were identified through review of reference lists and we later performed a web search.

We decided that all published trials in the TCC literature would be included if it meets the following criteria:

- 1-the article was an original report of the trial
- 2-the study was defined as an experimental study in which participants were randomly defined as mild cognitive impairment, Alzheimer's dementia or vascular dementia
- 3-one of the treatments tested was TCC

A minimum was required for inclusion in the summary research analysis and considered: randomization, explicit inclusion and exclusion criteria, homogeneity between groups, reasons for dropping out, reporting of measures

of variability. In order to assess strength of a body of evidence, research categorized qualitatively judged on methodological quality, quantity, and consistency of available research using a rating system. The quality of the trials publication was scoring by Jadad's Scale (**Table 1**)(19).

The authors reviewed the abstracts and full articles and discrepancies were resolved through discussion and consensus.

4. RESULTS

4.1. Brain functional area

We find eight scientific papers focused on brain functional area, made in USA (20)(21)(22)(23), Brazil (24), Japan (25) and China (26)(27).

Following the Jadad's quality classification, one of them was fulfilled strictly scientific rules (5 points), five of them have insufficient methodological analysis including TCC interventions (4 points), and two of them (3 points) have insufficient group randomization.

With regard to the methodology of study, one is a cross-sectional study, where they studied two population groups. A group was adults who never practiced TCC as a control and another group of former practitioners.

Seven papers corresponded to repeated - measures, namely, some tests were performed before and TCC practice interventions and were repeated measurements the same test throughout the duration of protocol in the control group as well as in the problem group.

The total number of persons who performed TCC adding all the eight protocols was two hundred fifty-nine, aged between 55 and 83 years and a mean of sixty-eight years. Nine patients had mild degree of dementia, the remaining population mild cognitive impairment.

Instructional time of TCC, namely, the duration of the protocols was: one year in two of them, ten months in other and finally eight weeks in five of them.

In one of the protocols there were three interventions TCC in the week, for the other two interventions weekly. The overall duration was one hour per section. In no case clarifies the training and experience of the instructors.

The indication of the styles used is underrated but is reported to one of the protocol Sun's Style, another works with Traditional Yang's Style, in two of the protocols used "versions" without specifying what style and in three of them was performed the 24 form.

The measuring instruments used, were: Mini Mental Status Examination (5 protocols), Color Trial Test (3 protocols), Rivermead Behavioral Memory Test (2

protocols), Berg Balance Scale (3 protocols), Dementia Rating Scale (3 protocols), Global Deterioration Scale (3 protocols), Timed Up and Go Test (2 protocols) and one performed the General Health Questionnaire and finally one used the Pittsburgh Sleep Quality Index. Table 2 explains how the tests were performed (**Table 2**).

4.2. Motor coordination functions

We find five scientific papers focused on brain and motor coordination functions that influence social exchange activity, the geographic distribution of research was: USA (28), China (29), Germany (30), United Kingdom (31) and Cuba (32).

Following the Jadad's quality classification, one of them was fulfilled strictly scientific rules (5 points), two of them have insufficient methodological analysis including TCC interventions (4 points), two researches (3 points) have insufficient group randomization and finally one of them (2 points) has almost no scientific structure and its own researchers indicated that is "quasi experiment".

All papers corresponded to repeated-measures methodology.

The total number of persons who performed TCC adding all the six protocols was two hundred eleven, aged between 55 and 84 years and a mean of sixty-seven years. Six patients had mild degree of dementia, the remaining population mild cognitive impairment.

Instructional time varied from eight weeks in one protocol, ten weeks in three protocols and two had six month of duration. In one of them there was three interventions TCC in the week, for three other two interventions conducted weekly and in two protocols practiced once in the week. In no case clarifies the training and experience of the instructors but five of them make explicit that the sections lasted an hour.

In three of the protocol does not specify any TCC style. Regarding the other three, one practiced the 24 form, another 12 postures form without specification and another practice some variations created for the protocol.

The measuring instruments used were: Color Trial Test (1 protocol), Falls Efficacy Scale (2 protocol), General Health Questionnaire (2 protocol), Timed Up and Go Test (2 protocols), Geriatric Depression Scale (2 protocol) and one performed the Tinetti's scale that evaluates gait (**Table 2**).

4.3. Effects of TCC en brain structure

Cerebral structure studied by photonics magnetic resonance and measured different areas of the brain subsequently using special software in two scientific papers. One conducted in China (33) and another made in China but the calculations were making in USA (34).

Following the Jadad's quality classification one of them reaches three points and the other four because the randomization is insufficient and no blind test, specifically, researchers always knew which subjects practiced TCC which could lead to subjective results according to international standards for scientific papers.

One of the protocols was a cross-sectional study and the other conducted as repeated-measures study.

In one of the protocols is performed a cross sectional study of twenty TCC practitioners, with an average of 14 years of practice (6-22 years of TCC) at least three times a week, and compared to a control population than never practice TCC. Practitioners belonged to Yang Style, Modify Chen Style, Wu-Hao Style and Sun Style.

Must be emphasized that not specified what kind of practice they performed or how deep was there knowledge of the styles, nor where they had learned. In another study performed three measures to twenty-nine people who practiced TCC for forty weeks, three times weekly. Measurements were before starting, in the week twenty and in the week forty. No specific TCC style used. As already, said measuring instrument was the high-definition Magnetic Resonance followed by morphometric reconstruction of the brain and processing in special software.

Both investigations concerning anatomical changes with increased volume of the brain or parts of the brain showed significant differences in favor of the group performing TCC practices (Table 2, item MRI) and all scientific papers except one (5%) showed significant improvements related to the practice of TCC.

To conclude the results section we present an interesting study conducted in U.S.A. employ measuring instrument model of subjective parameters created by the researchers, in people who continued to practice TCC after completed a research protocol. This study has already been wrote and reviewed by Dr. Yang Yang and poses a possible new analytical vision to analyze TCC practice results.

All scientific papers except one (5%) showed significant improvements related to the practice of TCC (**Table 3**).

Finally, we stress that all scientific papers except one (5%) showed significant improvements related to the practice of TCC, although varying degrees, in the tests used as measuring instruments.

5. CONCLUSIONS/DISCUSSION

The current review of the existing body of research investigating the therapeutic effects of TCC revealed global interest and exponential growth in number and quality of studies and range of clinical applications. While some years ago was strange in many parts of the Western world to see groups of individuals practicing TCC, today this scene is common.

The most often researched and strongest evidence of effect are in the areas of balance/falls/fear of falling, cardiopulmonary function, quality of life, bone and joint health. There is supporting research suggesting positive effect with regard to immune response, pain management, sleep quality and stress reduction as well as minimization of functional disability associated with cancer and arthritis. However this review focuses on cognitive impairment, Alzheimer's Disease and Vascular Dementia; we can say that there is supporting research suggesting positive effect with regard to immune response, pain management, sleep quality and stress reduction as well as minimization of functional disability associated with cancer and arthritis.

Reader cautions that these conclusions are time-dated to July 2013 and limited to articles with full text describing original clinical research. New evidences continues to emerge making the challenge to both stay abreast of new research and critically analyze the value of new knowledge an intimidating one.

In 90% of the papers had a proper development of background and goals of the research had been well-defined.

In addition, the majority of the reports (85%) had well-defined participants' eligibility criteria, and provided adequate description of statistical methods and reported the period of follow up of the study. Interpretations of results were correct.

On the other hand, the most poorly reported items were associated with allocation and implementation of randomization. In addition, less than 30 % of the trials clearly define the recruitment period. Finally, just two of them provided relative adequate details of TCC interventions.

In addition to insights into clinical applications, knowledge gained, emerging research has provided valuable information for the rational use of future research efforts.

While the potential of the collective intervention known as TCC appears high, additional research is still necessary to explore clinical areas where there has been insufficient or low quality study.

In addition, methodological design of future research is at issue. Future research must be designed using standardized tests and similar outcome measures to facilitate quantitative meta-analyses.

Today recommended a pluralistic methodological approach to clinical research that includes controlled randomized trials of fixed protocols, community-based realistic trials, cross-sectional studies of long-term practitioners, and studies that integrate qualitative methods.

TCC has complex concepts the discreet operationally defined interventions, than the question of what constitutes therapeutic TCC remains unanswered. TCC is an ancient art preserved within schools and evolved though centuries, it was evident that a number of different curricula and variations of similarly categorized curriculum employed from study to study. These data did not offer themselves to any comparisons of which curricula or styles might be prescriptively appropriate in each person and what dose is required to gain effect.

Quality of instruction also varied. For purposes of categorization in the current review, 'expert' instruction was operationally-defined as instruction provided by experienced instructors, nurses, certified TCC instructors, TCC trained physical therapists, but 100 % of the studies did not provide clear descriptions regarding the instructor expertise.

Finally, we stress that all scientific papers except one, showed significant improvements related to the practice of TCC, although varying degrees, in the tests used as measuring instruments including searches that measure brain volume and structure.

It is the hope of the authors of the current review that practice guidelines will emerge from integration of legacy teaching, clinical expertise and clinical research using theoretical foundations from both the belief system of Eastern energy cultivation and propositions of modern Western science.

Finally, in the modern promotion of TCC practice, questions of exercise prescription, curriculum, distribution, social marketing and professional education just beginning to investigate.

Table Nr.1 Validation of the clinical trials. Jadad's Scale.

Through these five questions can be an assessment of the validity of a clinical trial:

1. Was the study described as randomized (= randomized)? Yes = 1 point, No = 0 points.
2. Did describes the method used to generate the sequence of randomization and this method is suitable? Yes = 1 point, No = 0 points, the method is unsuitable = -1 point.
3. Was the study described as double blind? Yes = 1 point, No = 0 points.
4. Did describes the method of blinding (masking =) and this method is suitable? Yes = 1 point, No = 0 points, the method is unsuitable = -1 point.
5. Is there a description of withdrawals and dropouts tracking? Yes = 1 point, No = 0 points.

This questionnaire gives a score on a scale of 0-5 points, so that a higher score is better methodological quality randomized clinical trial (RCT) assessed. It is considered as "rigorous" a randomized clinical trial (RCT) of 5 points. An RCT is of poor quality if your score is less than 3 points.

The Jadad's Scale can be used to:

Assess the general quality of medical research in a particular field.

Establishing a minimum standard for the results of the studies should include a meta-analysis. A researcher to conduct a systematic review, for example, could choose to exclude all articles on the subject with a low Jadad's score.

Table Nr.2 Description of used tests.

Name of Test	Definition
Mini Mental Status	They are 11 questions covering five higher cognitive functions: orientation, retention, attention and calculation, memory and language. A result greater than 27 points (maximum 30) is considered normal, a score below 24 suggests a dementia, mild dementia a rating 23-21, 20-11 moderate dementia, severe dementia under 10.
Color Trial Test	Developed to be free from the influence of language and cultural bias, the CTT assesses sustained attention in adults. Numbered circles printed with vivid pink or yellow backgrounds that are perceptible to colorblind individuals. For Part 1, the respondent uses a pencil to connect circles numbered 1-25 in sequence. For Part 2, the respondent rapidly connects numbered circles in sequence, but alternates between pink and yellow. The length of time to complete each trial recorded.
Bergs's Balance Scale	The test takes 15–20 minutes and comprises a set of 14 simple balance related tasks, ranging from standing up from a sitting position, to standing on one foot. The degree of success in achieving each task is given a score of zero (unable) to four (independent), and the final measure is the sum of all of the score.
Geriatric Depression Scale	They are questions answered "yes" or "no", instead of a five-category response set. This simplicity enables the scale, with ill or moderately cognitively impaired individuals. The scale is a routine part of a comprehensive geriatric assessment. One point assigned to each answer and the cumulative score rated on a scoring grid. The grid sets a range of 0-9 as "normal", 10-19 as "mildly depressed", and 20-30 as "severely depressed".
Clinical Dementia Rating	It developed at the Memory and Aging Project at Washington University School of Medicine in 1979 for the evaluation of staging severity of dementia. It was developed primarily for use in persons with dementia of the Alzheimer type (the equivalent of probable Alzheimer's Disease) and it also be used to stage dementia in other illnesses as well. The Clinical Dementia Rating is a five-point scale in which CDR0 connotes no cognitive impairment, and then the remaining four points are for various stages of dementia: CDR0.5 = very mild dementia CDR1 = mild CDR 2 = moderate CDR 3 = severe
Time up to go Test	It is a simple test used to assess a person's mobility and requires both static and dynamic balance. It uses the time that a person takes to rise from a chair, walk three meters, turn around, walk back to the chair, and sit down. During the test, the person expected to wear their regular footwear and use any mobility aids that they would normally require. It used frequently in the elderly population, as it is easy to administer and can generally be completed by elder adults. One source suggests that scores of ten seconds or less indicate normal mobility, 11 – 20 seconds are within normal limits for frail elderly and disabled patients, and greater than 20 seconds means the person needs assistance outside and indicates further examination and intervention. A score of fourteen seconds or more suggests that the person may be prone to fall.
Falls Efficacy scale	On a scale of 0 to 10, it shows how confident are the patient to do or can do each activities without falling, with 0 meaning "not confident/not sure at all", 5 being "fairly confident/fairly sure", and 10 being "completely confident/completely sure".
General health Questionnaire	It is a questionnaire with 12 questions over concentration, sleep, sensations and facts of everyday life and social life over the last few weeks. Patient read and circle four possible answers 0-1-2-3: never to always.

Table Nr.3 Statistical significance of the findings. The value of "p" indicating that the association is statistically significant and were arbitrarily selected by consensus considered in 0.05. A 95% confidence implies a $p < 0.05$ and 99% security implies a $p < 0.01$. Similarly if $p > 0.05$ say that chance cannot be excluded as an explanation for this finding and do not reject the H_0 (null hypothesis) which states that the two variables are variables are not associated or correlated

Report Nr.	Test	Signification p=	Observation:
1	CTT RBMT	0.03 0.03	Moderate Moderate
2	MMSE BBS GDS	<0.001 <0.001 <0.001	High High High
3	MMSE DRS TUG	0.36 0.04 0.36	Low Moderate Low
4	CDR BBS GDS	0.04 0.02 0.02	Moderate Moderate Moderate
5	MMSE DSC GDS TUG	0.05 0.05 0.05 0.04	Moderate Moderate Moderate Moderate
6	RBMT SMC CTT	0.007 0.02 0.03	High Moderate Moderate
7	TUG GHQ PSQ GDS Sleep	No difference 0.05 0.05 0.02 0.006	Moderate Moderate Moderate Moderate High
8	BBS CTT Flexibility	0.04 <0.001 0.04	Moderate High Moderate
9	BBS TUG	0.05 0.03	Moderate Moderate
10	FES PSQI TMT	<0.001 <0.001 <0.001	High High High
11	BBT TUG	No difference No difference	
12	GHQ Mood Self esteem Flexibility	0.02 0.01 0.01 No difference	Moderate Moderate Moderate
13	Tinetti's: Motility Agility Balance Fall	<0.001 <0.001 <0.001 No difference	High High High
14	CTT TUG GDS	0.05 0.02 0.03	Moderate Moderate Moderate
15	CDR CTT SCWT MAGNETIC RESONANCE: INCREASE BRAIN VOLUME INCREASE BLOOD VOLUME	0.08 0.06 0.06 0.05 0.32	Moderate Moderate Moderate Moderate Moderate
16	MAGNETIC RESONANCE: *SUPERIOR TEMPORAL GYRUS *MEDIAL OCCIPITAL SULCUS *LINGUAL SULCUS *CIRCULAR SULCUS OF INSEL	<0.001 <0.001 <0.001 0.002	High High High High

Bibliography

- 1-Maturana H., Varela F.** *The tree of knowledge: biological roots of human understanding* (1984).Ed. LUMEN, Spain,1992
- 2-Lakoff G., Johnson M.** *Philosophy In The Flesh: The Embodied Mind and Its Challenge to Western Thought*. Basic Books, Computational Linguistics, vol. 25, no. 4, Dec. 1999.
- 3-Clark D.** International Handbook of Social Anxiety: Concepts, Research and Interventions Relating to the Self and Shyness. Edited by W. Ray Crozier and Lynn E. Alden.
© 2001 John Wiley & Sons Ltd
- 4-Thomson AM, Deuchars J.** *The Prefrontal Cortex and Flexible Behavior*. Neuroscientist (2007) 13 (5): 532-545.
- 5-Greenwood PM.** *Functional Plasticity in Cognitive Aging: Review and Hypothesis* . Am. Psyc. Assoc.,2007, Vol. 21, No. 6, 657-673
- 6-Nudo, R. J., Plautz, E. J., & Frost, S. B.** *Role of adaptive plasticity in recovery of function after damage to motor cortex*. Musc. & Nerve 2001, 24, 1000–1019.
- 7-Power J, Cohen A., Nelson S.,Gagan S., Barnes KA, Alecia C., Vogel T., Laumann O., Miezin F., Schlaggar B., Petersen S.** *Functional Network Organization of the Human Brain*. J. Neuron 2011,9:006
- 8-Merzenich M.M., Kaas J.H., Wall J., Nelson R.J., Sur M., Felleman D.** *Topographic reorganization of somatosensory cortical areas 3b and 1 in adult monkeys following restricted deafferentation*. Neuroscience 1983,8:33-55.
- 9-Leenders AGM, Sheng ZH.** *Modulation of neurotransmitter release by the second messenger-activated protein kinases: implications for presynaptic plasticity*. Pharmacology and Therapeutics 2005,105: 69-84.
- 10-Lonart G.** *An edge for presynaptic plasticity*. Trends in Neurosciences 2002, 25: 329-332.
- 11-Kleim J, Hogg T, van den Berg P, Cooper N, Bruneau R, Remple M** . *Cortical synaptogenesis and motor map reorganization occur during late, but not early phase of motor skill learning* . J Neuroscience 2004,24: 628-33.
- 12-Michaelsen SM, Levin MF.** *Short-term effects of practice with trunk restraint on reaching movements in patients with chronic stroke: a controlled trial*. Stroke 2004, 35(8):1914-9.
- 13-Flicker C; Ferris SH; Reisberg B.** *Mild cognitive impairment in the elderly: predictors of dementia*. Neurology 2009 Jul;41(7):1006-1009
- 14-Petersen, R., Smith, G., Waring, S., Ivnik, R., Kokmen, E.,Tangalos, E.** *Aging, memory and mild cognitive impairment*. Psychogeriatry 1997, 9, 65-69.
- 15-Petersen, R., Stevens, J., Ganguli, M., Tangalos, E., Cummings, J. y DeKosky, S.** *Practice parameter: Early detection of dementia: Mild cognitive impairment (an evidence based review)*. Neurology 2001, 56, 1133-1142
- 16-Collie A, Maruff P, Shariq-Antonacci R, Smith M, Hallup M, Schofield PR, Master CL, Currie J. .** *Memory decline in healthy older people: Implications for identifying mild cognitive impairment*. Neurology 2201,56:1533-1538
- 17-Dubois B, Feldman HH, Jacova C et al.** *Research criteria for the diagnostics of Alzheimer's Disease : revising the NNINCDS-ADRDA criteria*. Lancet Neurol. 6(8):734-46, 2007.
- 18-Van Straaten EC, Scjeltens P, Knol DL, van Buchen MA, van Dijk EJ, Hofman PA, Karas G, Kjaitansson O, de Leeuw FE, Prins ND, Schmolt R, Visser MC, Weinstein HC, Barkhof F.** *Operacional definitions for the NINDS-AIREN criteria for Vascular Dementia*. Stroke 2003 Aug 34(8):1907-12.
- 19- Jadad Bechara R.** *Journal of Controlled Clinical Trials 2007*.Blackwell. ISBN 978-1-4051-3266-4
- 20- Man DW, Tsang WW, Hui-Chan CW.** *Do older t'ai chi practitioners have better attention and memory function?*J. Altern Complement Med.2010 Dec;16(12):1259-64. doi: 10.1089/acm.2009.0462.
- 21- Burgener S, Yang Yang, Gilbert R, Marsh-Yant S.** *The Effects of a Multimodal Intervention on Outcomes of Persons With Early-Stage Dementia*. AM J Alz.Dis. Demen 2008 vol. 23,4:382-394

- 22-Taylor-Piliae RE, Newell KA, Cherin R, Lee MJ, King AC, Haskell WL.** Effects of *Tai Chi* and Western exercise on physical and cognitive functioning in healthy community-dwelling older adults. *J. Aging Phys. Act.* 2010 Jul;18(3):261-79.
- 23-Blake H, Barson M.** Exercise intervention in brain injury: a pilot randomized study of *Tai Chi Qigong*. *Clin. Rehabil.* 2009 Jul;23(7):589-98. doi: 10.1177/0269215508101736. Epub 2009 Feb 23.
- 24-Tizon Kasai JY, Busse A L, Miksian Magaldi R, Soci MA, de Moraes Rosa P, Esper Curiati JA, Jacob Filho W.** Effects of *Tai Chi Chuan* on cognition of elderly women with mild cognitive impairment. <<http://apps.einstein.br/revista/arquivos/PDF/1470-Einsteinv8n1p40-45.pdf>>
- 25-Wang W, Sawada M, Noriyama Y, Arita K, Ota T, Sadamatsu M, Kiyotou R, Hirai M, Kishimoto T.** *Tai Chi* exercise versus rehabilitation for the elderly with cerebral vascular disorder: a single-blinded randomized controlled trial. *Psychogeriatr.* 2010 Sep; 10(3):160-6
- 26-Kwok TC, Iam KC, Wong PS, Chau WW, Yuen KS, Ting KT, Hueng EW, Li JC, Ho FK.** Effectiveness of coordination exercise in improving cognitive function in older adults: a prospective study. *Clin. Interv. Aging* 2011;6:261-7. doi: 10.2147/CIA.S19883.
- 27-Lam LC, Chau RC, Wong BM, Fung AW, Tam CW, Leung GT, Kwok TC, Leung TY, Ng SP, Chan WM.** A 1-year randomized controlled trial comparing mind body exercise (*Tai Chi*) with stretching and toning exercise on cognitive function in older Chinese adults at risk of cognitive decline. *J. AM. Med Dir. Assoc* 2012 Jul;13(6):568.e15-20. doi: 10.1016/j.jamda.2012.03.008. Epub 2012 May 11.
- 28-Hung Nguyen M, Kruse A.** A randomized controlled trial of *Tai chi* for balance, sleep quality and cognitive performance in elderly Vietnamese. *Clin Interv Aging*. 2012; 7: 185-190.
- 29-Au-Yeung S, Hui-Chan C, Tang J.** Short-form *Tai Chi* Improves Standing Balance of People With Chronic Stroke. *Neurorehabil Neural Repair* 2009 Jan, doi:10.1177/1545968308326425
- 30-Hall CD, Miszko T, Wolf SL.** Effects of *Tai Chi* intervention on dual-task ability in older adults: a pilot study. *Arch. Phys. Med. Rehabil.* 2009 Mar;90(3):525-9. doi: 10.1016/j.apmr.2008.09.566.
- 31-Lavrestsky H, Alstein LL, Olamstead RE, Ercoli LM, Riàretto-Brown M, Cyr NS, Irwin MR.** Complementary use of *tai chi chih* augments escitalopram treatment of geriatric depression: a randomized controlled trial. *Am. J. Geriatr. Psychiatry* 2011 Oct;19(10):839-50. doi: 10.1097/JGP.0b013e31820ee9ef.
- 32-Hernandez Barea I, Cruz Torres W, Rodriguez Alarcón J, Gutierrez Aguilera N.** Effectiveness of *Tai Chi Chuan* Treatment in Fall Prevention in the Elderly. *Correo Científico Médico de Holguín* 2011; 15(1).
- 33-Gao-Xia W, Ting Xu, Feng-Mei F, Hao-Ming D, Li-li J, Hui-Jie L, Yang Zhi, Luo Mail J.** Can *Taichi* Reshape the Brain? A Brain Morphometry Study. *PLoS ONE* 2013 8(4): e61038. doi:10.1371/journal.pone.0061038
- 34-Mortimer JA, Ding D, Borstein AR, DeCarli C, Guo Q, Wu Y, Zhao Q, Chu S.** Changes in brain volume and cognition in a randomized trial of exercise and social interaction in a community-based sample of non-demented Chinese elders. *J Alz Dis* 2012;30(4):757-66. doi: 10.3233/JAD-2012-120079.