

The Atlanta FICSIT Study: Two Exercise Interventions to Reduce Frailty in Elders

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This study examines the effect of two different exercise approaches on balance and frailty measures among more than 200 community-dwelling individuals greater than 70 years of age. Exercises are provided for 15 weekly sessions on an individual basis for participants randomly assigned to a Balance Training group. Training consists of center-of-mass feedback displayed on a motor under static conditions, or, in later sessions, as the floor surface is moved, with eyes open or closed. This high technology interface provides instantaneous information about displacement of body weight in space so that balance can be enhanced. An alternative procedure is comparatively simple and requires little expense or space. Tai Chi Quan was originally developed as a martial arts form but has been used for centuries in China as an exercise among elderly citizens. Participants randomly as-

signed to this intervention meet twice weekly for 15 weeks to learn a condensation of 108 Tai Chi forms into 10 that emphasize movement components often restricted or absent with aging. A third group serves as a control for exercise interventions by meeting weekly for 15 sessions to discuss topics of interest such as memory loss, drug management, and nutrition. All subjects are screened prior to assignment, and a host of physical, behavioral, and functional measures are assessed before and after the intervention as well as 4 months later. Measurements unique to the Atlanta site include: balance with eyes closed, programmed force-distribution changes when stance is perturbed, cardiovascular assessments, WAIS, Affects Balance Scale, and a survey of home environment. *J Am Geriatr Soc* 41:329-332, 1993

Faculty in the Department of Rehabilitation Medicine at the Emory University School of Medicine have nurtured a tradition steeped in novel and creative conceptualizations designed to enhance physical function through therapeutic interventions. One such concept has been the use of ongoing visual and auditory cues of physiological behavior to correct aberrant movement among patients with musculoskeletal and neuromuscular disorders.

Our development of training strategies using biofeedback has been well documented.¹⁻⁴ Coincidentally, many of the patients among whom these strategies are applicable, primarily those with stroke, chronic low back pain, and demyelinating diseases, are also comparatively older. Our attention logically progressed toward other problems that prevented aging individuals from maintaining total independence, especially control over balance.⁵⁻⁷ Given our interest in feedback mechanisms, it seemed appropriate for us to explore the value of center-of-mass (force) feedback delivered through the resolution of outputs from several transducers positioned in supports resting upon a platform capable of being displaced. The output from these transducers can be presented to trainees on a color monitor situated at eye level.

This unique form of feedback offers a training strategy to enhance balance control and reduce the risk of falls under conditions of normal lighting, darkness, or during unexpected perturbations. As such, the proce-

dures represent the best of high technology using individualized training on a comparatively expensive apparatus. At the same time, our attention was drawn to an ancient oriental form of martial arts, Tai Chi (Taijiquan), practiced for centuries in China by elders (and youth) for agility, balance and posture control, and mind-body interactions.^{8,9} In Tai Chi, the body is naturally extended and relaxed, the mind is tranquil but alert, and body movements are slow, smooth, and well coordinated as the various "forms" are undertaken. Because Tai Chi is performed as a group activity, uses internal rather than external feedback, requires no technological interfaces, and emphasizes flexibility, strength, and cardiovascular improvements, this exercise intervention provides a profound contrast in balance training to the feedback instrumentation previously noted.

Accordingly, the Emory FICSIT intervention seeks to gather and evaluate functional, physical and behavioral measures using balance feedback training or Tai Chi to see whether (1) either approach improves any of these measures and (2) one technique yields more and longer lasting changes. Both of these groups are contrasted to a third group representing a control group. Members of the control group meet to become better acquainted with and exchange ideas and concerns regarding paramount issues about aging. The control group is instructed not to change their exercise habits while participating in the FICSIT study.

STUDY POPULATION AND SETTING

All participants at the Emory site are at least 70 years of age. Many live in the independent-living facility on quarters at the Wesley Woods Campus or are seen at the Wesley Woods Hospital as outpatients. All other research subjects are recruited locally through adver-

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tisements, eg, notices posted at meeting sites, such as places of worship, or through word of mouth. Because individual biofeedback training, group Tai Chi, and group educational (exercise control) classes all take place on the Wesley Woods campus, participants must be able to access their respective sites through personal vehicles, taxi, public transportation, or other resources. Most participants are independent ambulators, live in unsupervised environments, and have no progressive or debilitating conditions (severe cognitive impairments, metastatic cancer, major stroke, crippling arthritis) that would preclude active involvement within their randomly assigned intervention. Individuals with vestibular or other non-progressive or non-debilitating neurological disorders are eligible. Subjects taking medications known to affect balance are identified, and the influence of these drugs on falls or injurious falls is noted. Recruits tend to be active community dwellers with busy schedules and a dedication to health awareness and promotion of fitness.

We anticipate that at least half our participants will have experienced falls in the past year. It is our hope that the exercise interventions noted below will reduce falls among those subjects who have had them in the past year and prevent falls among subjects who had not experienced previous falls.

Subjects are screened to assure they meet the criteria noted above. Those individuals wishing to participate are then given a comprehensive evaluation which includes data acquisition for a host of physical, behavioral, psychosocial, functional, and environmental measures. After 36 subjects have successfully undergone pre-intervention evaluations, they are randomly assigned to one of three groups. Tai Chi and educational classes each contain 12 participants, while feedback balance training is performed on an individual basis. This process is repeated six times for a total recruitment of 216 individuals.

INTERVENTION SPECIFICS

Two exercise interventions, center-of-mass feedback and Tai Chi, and one exercise control intervention, educational issues relevant to aging, form the bases for the study. Each intervention lasts 15 weeks. The feedback trainees are treated individually once a week, Tai Chi groups meet twice a week to complete learning one "form," and the control group meets once a week. All subjects are followed for an additional 4 months after the intervention at which time a complete re-evaluation is performed.

Balance Training Using Center-of-Mass Feedback This individualized intervention is divided into 15 weekly individual sessions for an estimated total of 60 participants. Training progresses on a balance platform from which visual feedback of center of mass changes is given to the subject. Most training sessions are undertaken using both eyes open and eyes closed strategies. Changes in center of mass leave a "streamer" behind the moving cursor so that participants can subsequently see these changes after concluding their training under no vision conditions.

After being introduced to the balance-training de-

vice, subjects are taught how to weight shift so that the center of mass is moved to specified circular or rectangular targets strategically placed on the monitor. These tasks are performed using progressively smaller and more widely spaced targets. To achieve weight shifting in a timely manner, subjects must learn to alter their weight-bearing surfaces on one or both feet. With further training, similar targets are placed on the monitor, but the platform can now be electronically moved at varying speeds in either linear or angular directions. Either a target must be maintained under these circumstances, or subjects must shift their center of mass between specific targets. Some training sessions require that participants stand on the platform at a 90 degree change, thereby being moved from left to right or vice versa rather than in a forward-backward direction.

Tai Chi Training Taijiquan usually incorporates 108 "forms" or body movement sequences. These forms have been reduced to 10 which are taught to six separate groups of approximately 10 participants per group. The forms are learned and practiced over 15 weeks, with each group meeting 1 hour per session twice a week so that sufficient individual instruction can be acquired.

The delineation of 10 forms represents a reasonable synthesis of all movement patterns that can be reduced to those elements frequently perceived as movement limitations in older individuals. Ten forms also appear to be an appropriate number for our subjects to learn, given the time constraints of the study. We have identified seven therapeutic elements in Tai Chi. These elements are (1) continuous movement, performed slowly; (2) small to large degrees of motion; (3) knee flexion and weight shifting; (4) straight and extended head and trunk; (5) combined rotation of head, trunk and extremities; (6) asymmetrical diagonal arm and leg movements about the waist; and (7) unilateral weight bearing with constant shifting. The forms modified for this study become progressively more difficult. The first and last forms are considered "commencing" forms and incorporate elements 1-4, while forms 2-9 progressively employ more elements. Forms 8 and 9, for example, emphasize weight shifting and trunk/body rotation onto single limb support, thus making use of all seven therapeutic elements.

Control (Education Group) The composition of this group is identical to Tai Chi. Six cohorts of approximately 10 per group meet over 15 consecutive weeks for 1-hour intervals. The discussions are organized and facilitated by a gerontology-nurse specialist. Many visual aids are used, and group discussion is encouraged and supported. Topics include memory loss, nutrition, sleep disorders, pharmacological management, and interactions with family and friends. These subjects do not engage in any additional exercises during their involvement in this project.

COMPLIANCE, CONTAMINATION, AND CO-INTERVENTIONS

All participants are asked to notify their appropriate instructors about impending absences. With few exceptions, the 96 subjects presently enrolled have adhered

to this request. Absenteeism is minor and attrition is <14%. The most common reasons for termination have been unanticipated illness or dissatisfaction with the group to which a subject has been randomly assigned. Individuals who miss 3 or more consecutive weeks are dropped. Thus far, subjects who have shown this string of absences have discontinued voluntarily. Participants have not altered their recreation or living habits during this study.

One monitoring concern encountered by the Emory group deals with accuracy of falls or near-falls accounts. Early on, subjects were not charting falls behavior on a daily basis, but summing any incidences at weekly submission of falls reports when they reported to their respective interventions. Occasionally, near falls would be omitted because, in retrospect, subjects would feel that a near fall was either an adverse (negative) event, perceived by group peers as a potential loss of independence, or was caused by an act of nature beyond their control. Their misperceptions have been clarified. Furthermore, all falls or near falls are now charted daily on specified charts hung in frequently viewed locations. Monthly follow-up compliance or provision (mailing) of falls and near-falls records is superb. Follow-up mailings proceed through 4 months after conclusion of each intervention.

OUTCOME MEASURES

In addition to frequency of falls and near falls, as well as falls-related trauma, data are being collected to measure a variety of biomedical, behavioral, and environmental variables. Measures that are common to all FICSIT sites are described elsewhere by Schechtman et al. Those measures that are unique to the Emory/Wesley Woods site are depicted in Table 1. These measures are grouped by domain and, wherever appropriate, units of quantification.

Among our measures of physical status, the Atlanta FICSIT investigators are interested in determining

whether balance-training interventions affect single limb support, particularly in the absence of vision. This concern is relevant to falls-related behaviors among elderly subjects because many falls and subsequent musculoskeletal traumas occur under conditions of poor illumination or during the night. Measurements of blood pressure at rest and following endurance walks may also reveal changes in cardiovascular status subsequent to training.

Several psychosocial measures may be affected by our interventions as well. By way of example, the Choice/Control/Mastery assessment is highlighted. The dimensions encompassed within this evaluation may well be sensitive to behaviors altered through successful completion of Tai Chi training or postural control change learned from the balance-training machine. Thus, control over one's own health is measured by two items from the *Americans' Changing Lives* research being conducted by the Institute for Social Research at the University of Michigan¹⁰: "How good a job do you feel you are doing in taking care of your health? Would you say excellent, very good, good, fair, or poor?" (5-point response scale from Excellent = 1 to Poor = 5), and "How much control do you think you have over your future health? Would you say you have a great deal of control, some, very little, or none at all?" (4-point scale from "A great deal of control" = 1 to "None at all" = 4). One social support item from the *Americans' Changing Lives* research is also asked. The item uses a 4-point scale to measure subjects' receipt of support that contributes to their health maintenance. Responses are followed by specifications of the relationship to the subject of the individual(s) who provide help. Self-esteem is measured by the 10-item scale developed by Rosenberg¹¹; scores range from 0 to 10, with a higher score indicating higher self-esteem. Mastery, as measured by seven items from the work of Pearlin and Schooler¹² is "the extent to which one regards one's life-chances as being under one's own control." Intrusiveness, a construct derived from the

TABLE 1. MEASURES UNIQUE TO THE EMORY/WESLEY WOODS SITE (FICSIT 5)

Measure	Units	Domain
Balance eyes closed	Seconds	Physical status
Single limb support—eyes open; eyes closed	Seconds	
Postural sway with platform	Forces transduced to voltage	Physical status
Displacement—eyes open; eyes closed		
Endurance walk—blood pressure	mm Hg	
Physical examination		
Isometric contractions: ankle, knee, hip	kg	
Body composition	Percent fat	
Recent exercise history		Mobility, activity
Chronic conditions questions (Angina, Glaucoma, Mental Health)		Health status
Total nutrition and HDL cholesterol	Percentage	
3-day diet history	mg and percentage	
WAIS: vocabulary and trails (selected items)	Test dependent	Cognitive status
Affects balance scale	5-pt. scale	Psychosocial
Choice/control/mastery	Primarily 4-pt. scale	
Occupation		Demographics
Spouse's occupation		
Years retired (if applicable)		
Survey of home environment	Height and distance	Environmental

work of Rotter,¹³ and, more recently, Devins,¹⁴ is measured by a single Likert-type item, "I still do everything I want to do," with responses on a four-point scale and a higher score indicating more intrusiveness.

The home dwellings of many participants are evaluated, with particular emphasis on kitchens and bathrooms. Measures are made of floor plans, surface areas, and height of relevant locations such as shelves and drawers. These environmental data are gathered by architect/engineers who will correlate these factors with falls or near-falls reports, changes in fear-of-falling questionnaire responses, and other behavioral and psychosocial tests. These relationships form the basis for determining if unique environmental attributes among our subjects, who live in diversified home sites, contribute to frailty or injuries. Subjects are selected for this descriptive substudy based upon past histories of falls. After inspections and measurements are completed, specific recommendations are provided to enhance safety in those locations where deficiencies are found.

Other measures shown in Table 1 reflect areas of interest to the multi-disciplinary mix of professionals at Atlanta FICSIT. The measures selected are ones expected to be sensitive to intervention-related changes in frailty states.

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