# Factors that influence exercise activity among women post hip fracture participating in the Exercise Plus Program

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Abstract: Using a social ecological model, this paper describes selected intra- and interpersonal factors that influence exercise behavior in women post hip fracture who participated in the Exercise Plus Program. Model testing of factors that influence exercise behavior at 2, 6 and 12 months post hip fracture was done. The full model hypothesized that demographic variables; cognitive, affective, physical and functional status; pain; fear of falling; social support for exercise, and exposure to the Exercise Plus Program would influence self-efficacy, outcome expectations, and stage of change both directly and indirectly influencing total time spent exercising. Two hundred and nine female hip fracture patients (age  $81.0 \pm 6.9$ ), the majority of whom were Caucasian (97%), participated in this study. The three predictive models tested across the 12 month recovery trajectory suggest that somewhat different factors may influence exercise over the recovery period and the models explained 8 to 21% of the variance in time spent exercising. To optimize exercise activity post hip fracture, older adults should be helped to realistically assess their self-efficacy and outcome expectations related to exercise, health care providers and friends/peers should be encouraged to reinforce the positive benefits of exercise post hip fracture, and fear of falling should be addressed throughout the entire hip fracture recovery trajectory.

**Keywords:** hip fracture, exercise, self-efficacy, outcome expectations, recovery

### Introduction

While there has been limited work in the implementation of exercise activities post hip fracture, there is some support to suggest important benefits for these individuals. Specifically, for those who have sustained a hip fracture, regular exercise (resistive and/or aerobic) improves mobility and quadriceps strength (Tinetti et al 1999; Mangione et al 2005; Tsauo et al 2005; Jones et al 2006), increases walking speed (Henderson et al 1992; Habris et al 1995; Jones et al 2006), and weight-bearing ability (Habris et al 1995). Despite the potential benefits of exercise, however, the majority of older adults do not participate in sufficient physical activity or exercise (Centers for Disease Control and Prevention Behavioral Risk Factor Surveillance System 2006), including those who have sustained a hip fracture.

A social ecological model is one of the most comprehensive approaches to explaining exercise behavior in older adults (Sallis 2003; Sallis et al 2006; United States Department of Health and Human Services 2000; Medley and Syme 2000). Specifically a social ecological model suggests that an individual's behavior is affected by a wide sphere of influences: intrapersonal, interpersonal, institutional/organizational, public policy, and the environment.

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### Intrapersonal factors

Intrapersonal factors include such things as physical and cognitive status. Age-related dysfunction of frontal systems, for example, can result in deficits in planning, organization, self-control, and awareness of problems, which are likely to affect the ability to perform functional activities or engage in regular exercise (Sarkisian et al 2000; Norwalk et al 2001; Wang et al 2002).

Other intrapersonal factures, such as physical and mental health status have been noted to influence self-efficacy and outcome expectations, with low mood disturbance and better overall mental health associated with stronger self-efficacy and outcome expectations (Gecht et al 1996; Kurlowicz 1998; Perkins and Jenkins 1998). Mental health influences exercise activity such that those who were depressed were less likely to exercise (Oliver and Cronan 2002; Bonnet et al 2005; Mangione et al 2005; Forkan et al 2006). Perceived physical health status also has been associated with adherence to exercise in older adults (Sin et al 2002; Brown et al 2003; Munneke et al 2003; Lee and Laffrey 2006). Further there is evidence that such things as gait and balance, functional status, pain, or fear of falling may further influence an individuals' willingness to engage in exercise activities (Cumming et al 2000; Bruce et al 2002; Li et al 2003; Delbacre 2004; Fletcher and Hirdes 2004; Martin et al 2005).

# Interpersonal factors

Two overriding theories help explain the interpersonal interactions that can influence exercise behavior and behavior change as related to exercise. The first is social cognitive theory and the theory of self-efficacy (Bandura 1997)which suggests that the stronger the individual's self-efficacy and outcome expectations, the more likely it is that he or she will initiate and persist with a given activity. Self-efficacy expectations are the individuals' beliefs in their capabilities to perform a course of action to attain a desired outcome, whereas outcome expectations are the beliefs that a certain consequence will be produced by personal action. Both self-efficacy and outcome expectations play an influential role in the adoption and maintenance of exercise behavior in older adults (Brassington et al 2002; Gyurcsik et al 2003; Estabrooks et al 2005; Li et al 2005; McAuley et al 2006).

The second theory is the transtheoretical model (TTM) (Prochaska and Velicer 1997), an integrative model of intentional behavior change. The central construct of the TTM is stage of change (SOC), which describes behavior change as a progression through a series of stages. Individuals can be classified into one of the following five stages:

Precontemplation, Contemplation, Preparation, Action and Maintenance. Precontemplation occurs when the individual has no intention to change behavior. Contemplation occurs when the individual is thinking about changing behavior, but not committed to the behavior change. Preparation refers to the period when the individual intends to change behavior sometime soon and is actively preparing. Action occurs when the individual has changed behavior recently (within the past six months). Maintenance occurs when the individual has maintained behavior change for a period longer than six months. These stages are directly related to exercise behavior. As individuals progress through the stages of change they report exercising more, are more fit based on physiological measures and have stronger self-efficacy expectations (Godin et al 2004; Ackerman et al 2005). Likewise, self-efficacy and outcome expectations increase from precontemplation to maintenance in older adults (Resnick and Nigg 2003; Schumann et al 2003; Godin et al 2004; Ackermann et al 2005; Riebe et al 2005).

There is a relationship between self-efficacy and outcome expectations with stage of change. Consistently, self-efficacy and outcome expectations increase from precontemplation to maintenance in older adults (Gorely and Gordon 1995). The older adult's beliefs about his or her ability to exercise and the benefits associated with exercise influences whether or not the individual is willing to initiate and/or adhere to an exercise program (ie, stage of change). Self-efficacy and outcome expectations therefore can have both a direct and indirect effect on exercise through stage of change.

Another important interpersonal factor influencing participation in exercise is social support from friends, family, and experts. Consistent with the theory of self-efficacy, when there is encouragement to exercise from family, friends, and/or experts, older adults are more likely to participate in regular exercise activities (Resnick et al 2002; Sharma et al 2005; Greene et al 2006; Lim and Laffrey 2006; Lippke and Ziegelmann 2006; Resnick et al 2006).

# Institutional/organization and environment and policy

The organizational structure and environment the older adult lives in and the policies that impact their communities can influence exercise activities as well (Takano et al 2002; Iwarsson 2005). Environments that facilitate function have been noted to be important factors in prevention of functional decline (Takano et al 2002; Crews 2005; Iwarsson 2005) and enabling people to achieve their highest level of function and well-being (Humpel et al 2002; Takano et al 2002).

Unfortunately, designated exercise space is generally limited in home and facility based settings (Mihalko and Wickley 2003) and outside walkways, hallways, and common areas are seldom used to promote physical activity. While there are general guidelines to encourage all adults to engage in 30 minutes daily of physical activity (Centers for Disease Control and Prevention, Merck Institute of Aging and Health 2004; Thompson 2003; National Blueprint for Increasing Physical Activity 2002), there are no policies to promote this and no specific guidelines post hip fracture.

Despite existing knowledge on the factors and theories related to exercise, the fact remains that older adults do not frequently exercise. Encouraging exercise is especially important for a post-hip fracture population, given that this is likely to optimize recovery. In recognition of this possibility, this investigative team undertook a clinical trial to motivate exercise behavior in older adults post-hip fracture, which included three treatment arms: a home-based exercise program (Exercise), a motivational intervention (Plus), the combination of the two (Exercise Plus Program), compared with routine care.

The purpose of this paper is to describe selected intraand interpersonal factors that influence exercise behavior in women post hip fracture who participated in this project. Model testing of factors that influence exercise behavior at 2, 6, and 12 months post hip fracture was done and consideration given to consistency and differences noted between these models. The full model hypothesized that demographic variables; cognitive, affective, physical and functional status; pain; fear of falling; social support for exercise, and exposure to the Exercise Plus Program would influence self-efficacy, outcome expectations, and stage of change both directly and indirectly influencing total time spent exercising. The 89 hypothesized relationships are demonstrated in Figure 1.

### **Methods**

# Study design

Data were derived from a randomized clinical trial using a repeated measure two by two design with participants randomized to one of four groups: exposure to the Exercise Plus Program (exercise plus motivation), the Exercise only component of the Exercise Plus Program, the Plus (or motivational) only component of the Exercise Plus Program, or routine care.

# Sample

Participants were recruited from 6 hospitals in the greater Baltimore area between July 2000 and September 2004.

A detailed description of eligibility and recruitment has been described elsewhere (Buie et al 2001). Briefly, eligible patients were female, 65 years of age or older, community-dwelling at the time of fracture, had a nonpathologic fracture within 72 hours preceding admission, and surgical repair of the hip fracture. Medical exclusions included evidence of symptomatic cardiovascular disease, neuromuscular conditions limiting exercise, or other conditions that increased risk when exercising home alone. Participants had to be walking without human assistance prior to the fracture and score ≥20 on the Folstein Mini Mental Status Exam (Folstein et al 1975). Also, informed consent and baseline measures had to be obtained within 15 days of the fracture to be eligible for randomization. Institutional Review Board approvals were obtained from the University of Maryland, School of Medicine as well as the study hospitals, and all enrolled subjects provided their own informed consent.

A total of 209 female hip fracture patients were consented within 15 days of the hip fracture. The majority of the participants were Caucasian (97%), and the average age of the participants was  $81.0\pm6.9$ . Approximately one third (34%) of the participants were married. The remaining were widowed (57%), never married (3%), or divorced or separated (6%). The average number of years in school was  $12.2\pm2.9$ .

# The intervention: The Exercise Plus Program

The Exercise Plus Program and theoretical premise of the program has been described in detail elsewhere (Resnick et al 2002a, 2007). Briefly, the Exercise component of the Exercise Plus Program is a home based exercise intervention administered by exercise trainers which incorporates an aerobic exercise program using a Stairstep (Yu-Yahiro et al 2001; Resnick et al 2007), a comprehensive strengthening program that covers all muscles groups, and stretching exercises which are part of the warm up and cool down periods. Participants were encouraged to perform aerobic activity at least 3 days per week and strength training two days per week. The Plus component was also implemented by an exercise trainer and included a self-efficacy based intervention using education, verbal encouragement through goal setting and positive reinforcement, removal of unpleasant sensations associated with exercise, and individualized cueing (Resnick et al 2002a, 2007). In all treatment groups visits from the trainer were initially twice a week for the first three months, once a week for the next three months, and then once a month in the final six months of

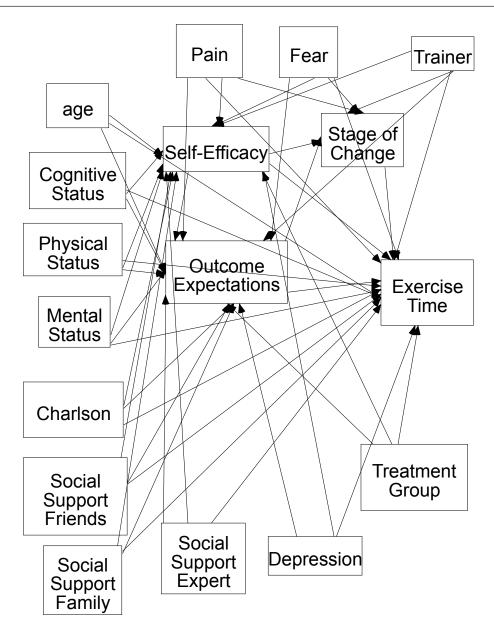


Figure I Full hypothesized model.

the program. On weeks when there was no face-to-face visit, for those exposed to the Plus component, weekly telephone calls were made to answer questions about exercise and encourage adherence.

### Measures

Follow up data was collected at 2, 6, and 12 months post hip fracture. Measures addressing intrapersonal factors included demographic information, the Short Form Health Survey (SF-36), the Centers for Epidemiologic Studies and Depression Scale, a single item fear of falling question, the numeric rating scale for pain; interpersonal factors included Social Support for Exercise Scale, the Self-efficacy for Exercise Scale (SEE), the Outcome Expectations for Exercise (OEE) scale, and the Stage of Change Questionnaire. The Yale Physical Activity Survey was used to measure time spent exercising. A description of the measures and reliability and validity is provided in Table 1.

# Data analysis

Descriptive statistics were done to describe the participants. Model testing was completed to establish the factors that influence exercise behavior at 2, 6, and 12 months post hip fracture using structural equation modeling and the Amos statistical program. The sample covariance matrix was used as input and a maximum likelihood solution sought. The

Table I Description of study measures

Measure	Description	Score range and interpretation	Reliability and validity
Self-efficacy for	A nine item	0 (no confidence)	Evidence of internal
Exercise:	measure that	to 10 (high	consistency (alpha=0.93),
(Resnick and	focuses on self-	confidence).	and validity based on a
Jenkins 2000)	efficacy	Higher scores	significant relationship
	expectations related	indicate stronger	between efficacy
	to the ability to	self-efficacy.	expectations and
	continue to exercise	•	moderate exercise, and
	in the face of		confirmatory factor
	barriers to		analysis. (Resnick and
	exercising.		Jenkins 2000).
Outcome	A nine item	l (strongly	Evidence of internal
	measure that	disagree) to 5	consistency (alphas
expectations for		• ,	, , ,
Exercise	focuses on the	(strongly agree).	ranging from 0.88 to 0.93)
(Resnick et al	perceived	Higher scores	and validity based on a
2000, 2001):	consequences of	indicate stronger	significant relationship
	exercise for older	outcome	between outcome
	adults.	expectations.	expectations and
			moderate exercise, and
			confirmatory factor
			analysis. (Resnick and
			Jenkins 2000).
The SF-36 (Ware	An eight dimension	0 to 14 for mental	There is support for the
and Sherbourne	measure of health	health; and 0 to	reliability (Chronbach's
1992).	status that focuses	100 representing	alpha for subscales
	on: physical	the percentage of	ranging from 0.75 to 0.86)
	. ,		
	functioning, role-	total possible score	and validity of this
	physical, bodily	achieved.	measure (based on
	pain, general health,		contrasting groups and
	vitality, social		factor analysis) when
	functioning, role		used with older adults
	emotional, and		(Stewart 1993, 1988;
	mental health.The		Walters and
	8 subscales are		Munro 2004).
	combined to		
	constitute mental		
	and physical health		
	scores.		
Yale Physical	A five category	0 to 1440 minutes	Evidence of test-retest
Activity Survey	physical activity	per week.	reliability (r = 0.63,
(YPAS)	survey that focuses	per week.	p < 0.001), and validity
,	•		
(DiPietro et al	on time spent in:		based on significant
1993)	housework,		correlations with
	caregiving,		physiological variables
	yardwork, exercise,		that are indicative of
	and recreational		habitual activity
	activities performed		(Dipietro et al 1993;
	during a typical		Pescatello et al 1994;
	week. Only the		Kolbe-Alexander et al
	exercise subscale		2006).
	was utilized in this		•
	study.		
Center for	The possible range	0 to 5. Higher	Prior use of these
	of scores is 0 to 60.	•	
pidemiological	of scores is 0 to 60.	scores indicate	measures provides
Studies		more depressive	evidence of their
Depression Scale		symptoms.	reliability and validity
(CESD)			when used with older
			(Continu

Table I (Continued)

Measure	Description	Score Range and	Reliability and Validity
		Interpretation	
(Radloff 1977;			adults (Radloff 1977;
Turk and Okifuji			Turk and Okifuji 1994
1994).			Caracciolo and Giaquinto
			2002; Bohannon et al
			2003; ).
Numeric Rating	A single item	0 (no pain) to 10	Evidence of test-retest
Scale (NRS) for	measure that	(the worst pain).	reliability (Spearman
Pain (Herr and	focuses on pain	Higher scores	rank correlations from
Mobily 1991)	over the previous	indicate more pain.	0.67 to 0.85) (Taylor et al
. ,	week.	·	2005), and concurrent
			validity with other pain
			measures (r = 0.56 to 0.90)
			(Herr and Mobily 1993;
			Herr et al 2004;Ware
			et al 2006)
Fear of Falling	A single item	0 (no fear) to 4 (a	Evidence of validity with
(Jorstad et al	measure that	lot of fear). Higher	fear of falling
2005 Resnick	focuses on fear of	scores indicate	significantly associated
1998)	falling.	greater fear of	with functional
	8.	falling.	performance in older
		8.	adults (Resnick 1998
			Jorstad et al 2005)
The Tinetti	A 17 item	0 to 26. Higher	Evidence of inter-rater
Mobility Scale	performance	scores indicate	reliability (r = 0.90), and
(Tinetti 1986)	measure that	better mobility.	construct validity with a
(1111etti 1700)	focuses on mobility	better mobility.	significant relationship
	and includes: nine		between mobility and
	balance maneuvers		falls (Tinetti 1986).
	and eight		ians (Tinetti 1700).
	and eight assessments related		
Th - C:-1	to gait.	Descible manage	Friday as afficenced
The Social	Includes three	Possible ranges	Evidence of internal
Support for	separate subscales	from 23 to 67.	consistency (alphas
Exercise Habits	of the same 15 items	Lower scores	ranging from 0.61 to 0.91)
Scale (Sallis	that reflect social	reflect lower social	and test retest reliability
et al 1987)	interactions that	support	(r = 0.55 to 0.79). Evidence
	might influence		of validity was based on
	exercise behavior		statistically significant
	from friends,		relationships between the
	family, and experts.		social support scale and
			exercise behavior (Sallis
			et al 1986) (Resnick
			et al 2002b).

chi-square statistic, the normed fit index (NFI), and Steigers Root Mean Square Error of Approximation (RMSEA) were used to estimate model fit. The larger the probability associated with the chi-square, the better the fit of the model to the data (Bollen 1989; Loehlin 1998). Since the chi-square statistic is sample size dependent the chi-square divided by degrees of freedom (df) was utilized to control for sample size effects (Bollen 1989). The NFI tests the hypothesized model against a baseline model and should be 1.0 if there

is perfect model fit. The NFI is "normed" so that the values cannot be below 0 or above 1. The RMSEA is a population based index and consequently is insensitive to sample size. An RMSEA of <0.10 is considered good, and <0.05 is very good (Loehlin 1998). Path significance (ie, significance of the Lambda values) was based on the Critical Ratio (CR), which is the parameter estimate divided by an estimate of the standard error. A CR >2 in absolute value was considered significant (Arbuckle 1997).

### Results

Of the 209 participants initially recruited, 165 women (79%) were available for 2-month assessments, 169 (81%) were available for 6-month follow up, and 155 (75%) were available for the 12-month follow up visits. One case was deleted post-randomization due to being ineligible (no surgery was performed post hip fracture). Reasons for loss to follow up have been reported elsewhere (Resnick et al pers comm). The mean age of the participants was  $80.7 \, (SD = 6.9)$ , mean MMSE was  $26.7 \, (SD = 2.8)$ , and the majority were Caucasian (96%).

The time from fracture to first intervention visit from the trainer ranged from 28 to 200 days. While attempts were made on the part of the trainers via weekly telephone calls to initiate the intervention, participants generally were not willing to have a visit occur prior to 2 months post fracture. Only one participant had her first visit at 28 days post fracture. By two months, 22 (31%) of the participants had their first visit, by three months 44 (62%) of the participants had their first visit, and by four months 58 (82%) of the participants had their first visit.

Table 2 provides descriptive statistics of the variables under study by treatment (any of the three intervention arms) versus control group. Generally the participants had some confidence they could exercise, believed in the benefits of exercise and exercised about 1.5 to 2 hours weekly. Overall they were not depressed and reported fair mental and physical health, minimal pain and some fear of falling.

Testing of the full 2 month model indicated that out of the 89 paths hypothesized only 7 were statistically significant (Figure 2). Path coefficients for all models are shown in Table 3. Cognitive status and comorbidities related to selfefficacy expectations such that those who had better cognitive status and fewer comorbidities had higher self-efficacy expectations. Self-efficacy expectations and social support for exercise from friends related to outcome expectations such that those with higher self-efficacy expectations and more support from friends to exercise had stronger outcome expectations. Outcome expectations directly related to stage of change such that those with stronger outcome expectations were more likely to be exercising. Self-efficacy and stage of change directly related to time spent in exercise, as those with stronger self-efficacy and a higher stage of change (eg., in maintenance versus precontemplation) spent more time exercising. While this model showed a good fit to the data ( $\chi^2 = 22.6$ , df = 14, p = 0.07, ratio 1.6; NFI = 0.84, and RMSEA of 0.05), it explained only 10% of the variance of exercise behavior at two months post hip fracture.

At six months post hip fracture (Figure 3), 12 of the 89 hypothesized paths were significant. Physical and mental health, social support from an expert, and treatment group all related to self-efficacy expectations such that those who were exposed to any of the treatment groups, had better health, and less support from an expert to exercise, had stronger self-efficacy expectations. Age, mental health, fear of falling and social support from friends related to outcome expectations for exercise. Those who were younger, had better mental health, more support from friends for exercise, and less fear of falling had stronger outcome expectations for exercise. Self-efficacy and outcome expectations were associated with stage of change such that those with stronger efficacy expectations were more likely to be in higher stages of change such as action or maintenance. Stage of change and treatment group were the only variables to directly relate to time in exercise, with higher stages of change and exposure to treatment being associated with more time spent in exercise. All the other significant variables indirectly related to exercise time through self-efficacy or outcome expectations and then stage of change. There was a fair fit of the model to the data ( $\chi^2 = 110.6$ , df = 38, p = 0.00, ratio 2.9, NFI = 0.74, and RMSEA of 0.09), it explained 8% of the variance of exercise behavior at six months post hip fracture.

At 12 months post hip fracture, nine of the 89 hypothesized paths were significant (Figure 4). Physical health and fear of falling related to self-efficacy expectations. Those with better health and less fear had stronger self-efficacy expectations. Self-efficacy expectations, social support from an expert, and fear of falling all related to outcome expectations for exercise. Those who had stronger self-efficacy, more support from an expert, and less fear of falling had stronger outcome expectations for exercise. As noted in the 6 month model, self-efficacy and outcome expectations related to stage of change, and those with stronger self-efficacy and outcome expectations were more likely to be in higher stages of change for exercise. Stage of change and exposure to treatment were the only variables directly related to time spent in exercise. All other variables indirectly related to time in exercise through self-efficacy and outcome expectations. There was a fair fit of the model to the data ( $\chi^2 = 59.7$ , df = 19, p = 0.00, ratio 3.1, NFI = 0.76, and RMSEA of 0.10), and the model explained 21% of the variance of exercise behavior at twelve months post hip fracture.

### **Discussion**

The findings from this study support prior findings and add to the understanding of the factors that relate to exercise behavior

**Table 2** Means (SE) for selected outcome measures by treatment group (total n = 208; treatment group n = 157; control = 51)

Control Treatment	1.8	1.6
Treatment		1.0
	1.9	1.6
Control	1.2	1.7
	1.9	1.8
Control	1.0	1.5
		1.9
		0.56 0.64
rreaument	3.7	
	3.8	0.64
Treatment	3.9	0.59
Control	3.7	0.66
Treatment	3.9	0.61
Control	6.5	2.3
	6.5	2.8
Cantual	Γ Ο	3.1
		2.5
		3.2
Ireatment	7.4	2.4
Control	12.2	9.3
Treatment	9.9	9.1
Control	11.8	9.2
Treatment	9.2	8.7
Control	9.0	7.7
		7.9
		6.9 4.5
rreacriteric	20.6	т.3
	17.3	5.7
Treatment	17.5	6.8
Control	20.2	5.2
Treatment	20.3	5.4
Control	31.3	11.8
	35.7	11.7
Control	34.9	14.6
		13.6
		15.6 14.0
rreaument	43.3	14.0
	40.9	13.8
Treatment	45.9	9.9
Control	47.8	12.0
Treatment	50.3	9.8
Control	49.7	10.1
	50.9	9.3
		2.3
		2.3
Control	2.6	3.2
		(Continued)
	Control Treatment Control	Treatment       1.9         Control       1.0         Treatment       2.2         Control       3.9         Treatment       3.9         Control       3.8         Treatment       3.9         Control       3.7         Treatment       3.9         Control       6.5         Treatment       6.5         Control       6.3         Treatment       7.4         Control       6.3         Treatment       7.4         Control       12.2         Treatment       9.9         Control       11.8         Treatment       9.2         Control       11.8         Treatment       9.2         Control       18.5         Treatment       20.6         Control       17.3         Treatment       17.5         Control       17.3         Treatment       20.3         Control       31.3         Treatment       20.3         Control       36.9         Treatment       40.8         Control       40.9         Treatment

Table 2 (Continued)

Variable		Mean	Std. Deviation
	Treatment	2.2	2.9
Yale: total exercise time 12mo, hrs/wk	Control	0.92	1.4
	Treatment	3.1	3.8
Pain 2 months	Control	3.7	2.2
	Treatment	4.1	2.8
Pain 6 months	Control	4.0	3.0
	Treatment	3.6	3.0
Pain 12 months	Control	3.7	2.9
	Treatment	3.1	2.9
Fear 2 months	Control	2.6	1.4
	Treatment	2.3	1.4
Fear 6 months	Control	2.4	1.4
	Treatment	2.0	1.5
Fear 12 months	Control	2.1	1.4
	Treatment	1.9	1.4
Social support experts 2 months	Control	17.5	6.4
	Treatment	18.9	4.1
Social support experts 6 months	Control	17.8	4.5
	Treatment	26.1	8.2
Social support experts 12 months	Control	17.5	6.4
	Treatment	18.9	18.9
Social support friends 2 months	Control	17.4	2.6
	Treatment	17.6	3.6
Social support friends 6 months	Control	18.2	3.8
	Treatment	18.0	3.6
Social support friends 12 months	Control	17.4	2.6
	Treatment	17.6	3.6
Social support family 2 months	Control	22.2	7.8
	Treatment	22.2	6.0
Social support family 6 months	Control	19.6	4.7
	Treatment	20.9	6.5
Social support family 12 months	Control	21.1	8.9
	Treatment	19.8	5.6

in older adults, particularly those who have sustained a hip fracture. The three predictive models tested across the 12 month recovery trajectory suggest that somewhat different factors may influence exercise over the recovery period. At two months post hip fracture the participants were just beginning to be exposed to the intervention, which may explain why treatment group status was not related to exercise behavior. However, 6 and 12 months post fracture the exposure to treatment did relate to time spent doing exercise; this finding speaks well to the effort of encouraging exercise. Although there were five different trainers providing treatment during the course of the study, there was no evidence

of trainer effect during any of the testing time points. Thus, the benefits of encouraging exercise are not trainer-specific, and the skills to be an effective trainer may be easily learned.

Similar to prior studies with community dwelling older adults (Litt et al 2002; Resnick and Nigg 2003; Benjamin et al 2005; Stiggelbout et al 2006), self-efficacy and outcome expectations related to stage of change for exercise, which directly related to exercise behavior. However, with the exception of the two month testing time point, self-efficacy and outcome expectations had no direct relationship with exercise. Instead, they indirectly related to exercise through stage of

**Table 3** Path coefficients for significant paths in hypothesized models

Path Tested	2 Month Model	6 Month	I2 Month
		Model	Model
Cognitive status $\rightarrow$ Self-efficacy	0.29(0.00)		
Comorbidities $\rightarrow$ Self-efficacy	-0.15(0.04)		
Physical health $\rightarrow$ Self-efficacy		0.20 (0.04)	0.37(0.00)
Mental health $ o$ Self-efficacy		0.27(0.01)	
Social Support Experts $ o$ Self-efficacy		-0.20(0.01)	
Treatment group $\rightarrow$ Self-efficacy		0.20(0.01)	
Fear $\rightarrow$ Self-efficacy			-0.25(0.00)
Age $ o$ Outcome expectations		-0.20 (0.01)	
Mental Health $ o$ Outcome expectations		0.28(0.01)	
Social Support Friend → Outcome expectations	0.29(0.00)	0.19(0.01)	
Social Support Experts $ ightarrow$ Outcome expectations			0.15(0.04)
Fear $\rightarrow$ Outcome expectations		-0.23(0.00)	-0.23(0.00)
Self-efficacy $ o$ Outcome expectations	0.39(0.00)		0.39(0.00)
Self-efficacy $ o$ Stage of change		0.24(0.00)	0.26(0.00)
Outcome expectations $ o$ Stage of change	0.44(00)	0.33(0.00)	0.36(0.00)
Self-efficacy $ o$ Exercise time	0.25(0.00)		
Stage of change $ o$ Exercise time	0.15(0.04)	0.20(0.01)	0.42(0.00)
Treatment group*→ Exercise time		0.20(0.01)	0.17(0.02)

<sup>\*</sup>Exposure to any component of the intervention (Exercise only, Motivation only, Exercise Plus Motivation) versus routine care

change. Although there have been multiple studies supporting a direct relationship between self-efficacy and/or outcome expectations with exercise (Booth et al 2000; Rhodes et al 2001; Brassington et al 2002; Litt et al 2002; Conn et al 2003a, 2003b; O'Connor 2004; Cress M 2005; Sharma et al 2005; Taylor-Piliae and Froelicher 2005; Lee and Laffrey 2006; Wilcox et al 2006), this relationship has not been consistent among older adults. In a recent study (Stiggelbout et al 2006) of community dwelling older adults involved in exercise programs, self-efficacy influenced intention to exercise but not actual exercise behavior. The lack of relationship between self-efficacy and actual exercise behavior was also noted in a sample of older adults participating in a home-based exercise program viewed on television (Hopman-Rock et al 2005) and among older adults post stroke (Resnick pers comm). Thus, the results of this study add to the evidence suggesting that interventions might best be targeted at encouraging selfefficacy related to readiness to adopt exercise behavior, after which time doing exercise will increase.

The lack of a direct relationship between outcome expectations and exercise behavior in older adults post hip fracture may be due to the sample studied and a ceiling effect of the measure. That is, these individuals had all volunteered to participate in an exercise intervention study and therefore were likely to have high outcome expectations related to exercise. Indeed, at baseline (2 months post hip fracture), the majority of participants agreed with the positive benefits associated with exercise on the outcome expectations

measure and had a high mean score of 3.9 (SD = 0.69 and range of 1 to 5) (Resnick 2006).

Age, cognitive status, and comorbidities had a limited indirect relationship with exercise behavior. The participants were, however, all older adults and had to meet specific cognitive criteria and be free of a large number of comorbidities to be eligible to participate in the study. Consequently, the homogeneity of the sample may have influenced findings. Nonetheless, results suggest that in a similar population of older adults with hip fractures, age, cognition, and health are not a deterrent to exercise. Perceptions of physical and mental health status were noted to relate to self-efficacy and/or outcome expectations at 6 and 12 months post fracture, with those in better perceived health having stronger self-efficacy or outcome expectations, which then indirectly influenced time spent in exercise. Clinically, it is important to recognize that those with poorer health are likely to have lower self-efficacy and outcome expectations associated with exercise and may benefit from interventions to strengthen those beliefs. In particular it is critical that individuals with perceptions of poor health status understand and believe that it is safe for them to exercise and that there will be a benefit to doing so (Resnick et al 2005).

The relationship between self-efficacy and outcome expectations for exercise and fear of falling noted in this study has not been reported in prior research. The study findings suggest that the relationship between fear and exercise may be mediated by self-efficacy and outcome expectations, as

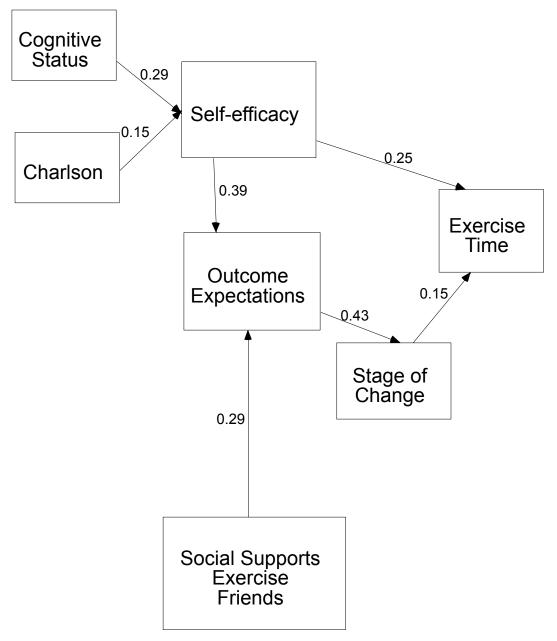


Figure 2 Two month model significant paths only.

was demonstrated at 6 and 12 months post hip fracture. It is of note that the impact of fear seems most prevalent at 12 months post fracture rather than in the more immediate post fracture period (eg, 2 months post fracture). It seems likely that individuals further along in the recovery trajectory may be engaging in more activity, and thereby reconsidering their fear in the face of that activity. This suggests that ongoing efforts might be made to address the fear of falling experienced by individuals well after their initial fracture.

Exposure to the intervention did not directly relate to selfefficacy and outcome expectations, as was anticipated (Resnick et al 2002a) although there were non-significant trends of an increase or maintenance of efficacy expectations in the treatment group and a decline in the control group. The lack of a significant impact on self-efficacy and outcome expectations may in part be due, as indicated previously, to the sample included in the study (ie, volunteers in an exercise intervention study) and ceiling effects of these measures. It is also possible that, post hip fracture, older adults may evaluate their self-efficacy and outcome expectations based on their prior health status, not current status post hip fracture. Consequently, as noted in this study, a self-efficacy based intervention improved exercise behavior but did not influence self-efficacy or outcome expectations in the first year post hip fracture.

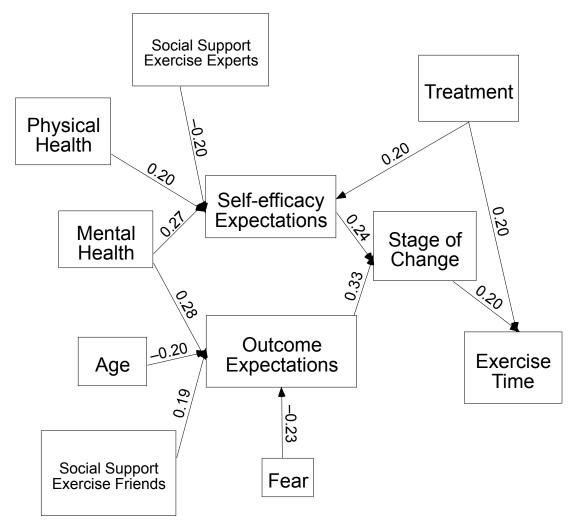


Figure 3 Six month model significant paths only.

Ongoing research is needed to explore the measurement of self-efficacy and outcome expectations post hip fracture, and establish ways to help older adults carefully evaluate their self-efficacy and outcome expectations related to exercise in the face of an acute clinical change. This is important because self-efficacy based interventions may be even more effective when the participant realistically appreciates his or her true efficacy expectations.

Social support for exercise from friends related to self-efficacy for exercise at 2 and 6 months post hip fracture. This finding has been inconsistent in prior research with social support for exercise from friends relating to exercise behavior among some samples of community dwelling older adults (Booth et al 2000; Resnick et al 2002b), but not others (Eyler et al 1999; Brassington et al 2002). It is possible that interactions with peers, possibly peers who themselves exercise (and may have experienced a hip fracture), has a positive influence on self-efficacy related to exercise post hip fracture.

Practitioners should consider the use of peers to strengthen beliefs and thereby improve exercise behavior in older adults post hip fracture as was done in a recent study testing a group based exercise program for older adults post hip fracture led by an older adult trainer (Jones et al 2006).

Social support for exercise from experts (anyone perceived by the participant to be an expert) was negatively related to self-efficacy expectations at 6 months post hip fracture. Although it was anticipated that social support on the part of the experts would increase time spent in exercise there are several possible explanations for the negative relationship. Social support for exercise did increase from two months to six months post fracture in the treatment group (18.9 to 26.1) while staying essentially unchanged in the control group (17.5 to 17.8). It is possible that this increase in social support from the experts was not related to exercise behavior, with other factors taking on a greater precedence. It is also possible, since the intervention did not control

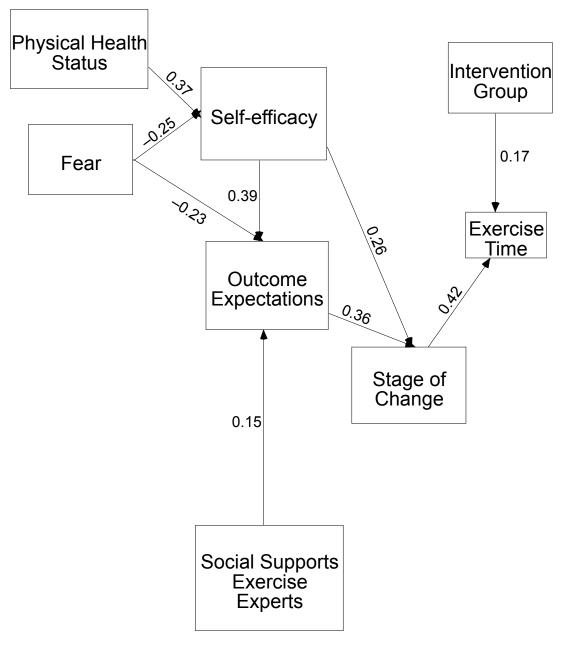


Figure 4 Twelve month model significant paths only.

the interactions between the participants and any of their health care providers (primary care physicians, nurses, nurse practitioners, or surgeons), that some negative interchanges related to exercise may have occurred. We had experiences, for example, in which some participants were told *not to* exercise by their orthopedist or primary medical doctor (Resnick 2005). Future research should seek to understand the ongoing exchanges between patients and providers for this reason.

While the revised models with significant paths had a fair to good fit with the data, they only explained a small amount of the variance in exercise behavior (8% to 20%). The many non-

significant hypothesized predictors further support the challenges associated with increasing exercise activity among older adults, particularly those who have sustained a hip fracture. Specifically, pain, depressive symptoms, and gait and balance consistently had no direct or indirect influence on exercise behavior. Using the social ecological model of behavior, possible factors that might influence exercise behavior among older adults but were not considered in this study could be added to future work, including environmental and policy considerations (eg, providing financial incentives for participation in exercise or establishing safe walking paths within communities) (Booth et al 2000), whether or not the individual had to stop exercise for a period

due to an acute event (Stiggelbout et al 2006), or consideration of life events such as the death of a loved one, pet, or change in location (Wilcox and King 2004).

#### Limitations

This study was limited in that the sample size was small and homogenous which influenced model fit results and the likely replicability of the findings. However, despite these limitations, the findings provide some guidance for future work in the area of developing interventions to increase exercise post hip fracture, as well as measurement challenges for social cognitive constructs post hip fracture (ie, accurate assessment of self-efficacy and outcome expectations). In addition to helping older adults post hip fracture realistically readjust their self-efficacy and outcome expectations related to exercise, the research team recommends that health care providers and friends/peers reinforce the positive benefits of exercise post hip fracture, and continue to address fear of falling throughout the entire hip fracture recovery trajectory, as well as explore additional factors that may influence time spent in exercise post hip fracture.

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#### References

- Arbuckle J. 1997. Amos users' guide version 3.6, Chicago, Small Waters Corporation.
- Bandura A. 1997. Self-efficacy: The Exercise of Control., New York, New York, W.H. Freeman and Company.
- Benjamin K, Edwards NC, Bharti VK. 2005. Attitudinal, perceptual, and normative beliefs influencing the exercise decisions of community-dwelling physically frail seniors. *Journal of Aging and Physical Activity*, 13:276–93.
- Bohannon RW, Maljanian R, Goethe J. 2003. Screening for depression in clinical practice: reliability and validity of a five-item subset of the CES-Depression. *Perceptions and Motor Skills*, 97:855–63.
- Booth ML, Owen N, Bauman A, et al. 2000. Social-cognitive and perceived environment influences associated with physical activity in older Australians. Preventive Medicine, 31:15–22.
- Brassington GS, Atienza A, Perczek et al. 2002. Intervention-related cognitive versus social mediators of exercise adherence in the elderly. *American Journal of Preventive Medicine*, 23:80–6.
- Bruce DG, Devine A, Prince RL. 2002. Recreational physical activity levels in healthy older women: the importance of fear of falling. *Journal of the American Geriatrics Society*, 50:84–9.

- Buie V, Orwig B, Resnick B, et al. 2001. Frail Elderly women posthip fracture: Recruitment and retention into a 12-month exercise intervention study. *The Gerontologist*, 41:41–57.
- Caracciolo B, Giaquinto S. 2002. Criterion validity of the center for epidemiological studies depression (CES-D) scale in a sample of rehabilitation inpatients. *Journal of Rehabilitation Medicine*, 34:221–5.
- Centers for Disease Control and Prevention, 2006. behavioral risk factor surveillance system 2006 [online]. Accessed on December 12, 2006. URL:https://www.cdc.gov/brfss.
- Centers for Disease Control and Prevention, Merck Institute of Aging and Health. 2004. The State of Aging and Health in America, 2004: 21–6
- Conn VS, Burks KJ, Pomeroy SL, et al. 2003a. Are there different predictors of distinct exercise components? *Rehabilitation Nursing*, 28:87–91.
- Conn VS, Tripp-Reimer T, Maas ML. 2003b. Older women and exercise: theory of planned behavior beliefs. *Public Health Nursing*, 20:153–63.
- Cress MB, Prohaska T, Rimmer J, et al. 2005. Best practices for physical activity programs and behavior counseling in older adult populations. *Journal of Aging and Physical Activity*, 13:61–74.
- Crews D. 2005. Artificial environments and an aging population: Designing for age related functional losses. *Journal of Physiological Anthropology*, 24:103–9.
- Cumming RG, Salkeld G, Thomas M, et al. 2000. Prospective study of the impact of fear of falling on activities of daily living, SF-36 Scores, and nursing home admission. *Journal of Gerontology*, 55:299–305.
- Delbacre K, Crombez G, Vanderstraeten G, et al. 2004. Fear related avoidance of activities, falls and physical frailty: A prospective community based cohort study. *Age and Ageing*, 33:368–73.
- Dipietro L, Caspersen CJ, Ostfeld AM, et al. 1993. A survey for assessing physical activity among older adults. *Medicine Science Sports and Exercise*, 25:628–42.
- Eyler AA, Brownson RC, Donatelle RJ, et al. 1999. Physical activity social support and middle- and older-aged minority women: results from a US survey. Social Science Medicine, 49:781–9.
- Fletcher P, Hirdes J. 2004. Restriction in activity associated with fear of falling among community-based seniors using home care services. *Age Ageing*, 33:273–9.
- Folstein MF, Folstein SE, Mchugh PR. 1975. "Mini-Mental state" A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, 12:189–98.
- Habris R, O'Hara P, Harper D. 1995. Functional status of geriatric rehabilitation patients: a one year follow-up study. *Journal of the American Geriatric Society*, 36:890–6.
- Henderson SA, Finlay OE, Murphy, et al. 1992. Benefits of an exercise class for elderly women following hip surgery. *Ulster Medical Journa*, 61:144–50
- Herr K, Mobily P. 1993. Comparison of selected pain assessment tools for use with the elderly. *Applied Nursing Research*, 6:39–46.
- Herr K, Spratt K, Mobily P. et al. 2004. Pain intensity assessment in older adults: use of experimental pain to compare psychometric properties and usability of selected pain scales with younger adults. *Clinical Journal of Pain*, 20:207–19.
- Herr KA, Mobily PR. 1991. Complexities of pain assessment in the elderly. Clinical considerations. *Journal of Gerontological Nursing*, 17:12–9.
- Hopman-Rock M, Borghouts JA, Leurs MT. 2005. Determinants of participation in a health education and exercise program on television. *Preventive Medicine*, 41:232–9.
- Humpel N, Owen N, Leslie E. 2002. Environmental factors associated with adults' participation in physical activity: A review. American Journal of Preventive Medicine, 22:188–99.
- Iwarsson S. 2005. A long-term perspective on person-environment fit and ADL dependence among older Swedish adults. The Gerontologist, 45:327–36.
- Jones G, Jakobi J, Taylor A, et al. 2006. Community exercise program for older adults recovering from hip fracture: A pilot study. *Journal of Aging and Physical Activity*, 14:439–55.
- Jorstad E, Hauer K, Becker C, et al. 2005. Measuring the psychological outcomes of falling: a systematic review. *Journal of the American Geriatrics Society*, 53:501–10.

- Kolbe-Alexander TL, Lambert EV, Harkins JB, et al. 2006. Comparison of two methods of measuring physical activity in South African older adults. *Journal of Aging and Physical Activity*, 14:98–114.
- Lee Y, Laffrey S. 2006. Predictors of physical activity in older adults with borderline hypertension. *Nursing Research*, 55:110–20.
- Li F, Fisher J, Harmer P, et al. 2003. Fear of falling in elderly persons: association with falls, functional ability, and quality of life. *Journal of Gerontology*, 58:283–90.
- Litt M, Kleppinger A, Judge J. 2002. Initiation and maintenance of exercise behavior in older women: Predictors from the social learning model. *Journal of Behavioral Medicine*, 25:83–97.
- Loehlin J. 1998. Latent variable models. New Jersey, Lawrence Erlbaum Associates.
- Mangione KK, Craik RL, Tomlinson SS, et al. 2005. Can elderly patients who have had a hip fracture perform moderate- to high-intensity exercise at home? *Physical Therapy*, 85:727–39.
- Martin FC, Hart D, Spector T, et al. 2005. Fear of falling limiting activity in youngold women is associated with reduced functional mobility rather than psychological factors. *Age and Ageing*, 34:281–7.
- Mihalko S, Wickley K. 2003. Active living for assisted living: Promoting partnerships within a systems framework. American Journal of Preventive Medicine, 25:193–203.
- National Blueprint for Increasing Physical Activity. 2002. National Blueprint for increasing physical activity among adults 50 and older, Creating a strategic framework and enhancing organizational capacity for change. *Journal of Aging and Physical Activity*, 9:S5–28.
- O'Connor BP, Rousseau FL, Maki SA. 2004. Physical exercise and experienced bodily changes: the emergence of benefits and limits on benefits. *Interna*tional Journal of Aging and Human Development, 59:177–203.
- Pescatello L, Dipietro L, Fargo A, et al. 1994. The impact of physical activity and physical fitness on health indicators among older adults. *Journal of Aging and Physical Activity*, 2:2–13.
- Radloff LS. 1977. The CES-D Scale: A self-report depression scale for research in the general population. Applied Psychological Measures, 1:385–401.
- Resnick B. 1998. Functional performance of older adults in a long term care setting. *Clinical Nursing Research*, 7:230–46.
- Resnick B. 2006. The Baltimore Hip Studies: Hip 4 and Hip 5. University of Maryland Unpublished Data Analysis.
- Resnick B, Jenkins LS. 2000. Testing the reliability and validity of the Self-Efficacy for Exercise scale. *Nursing Research*, 49:154–9.
- Resnick B, Magaziner J, Orwig D, et al. 2002a. Evaluating the components of the Exercise Plus Program: Rationale, theory and implementation. *Health Education Research*, 17:648–59.
- Resnick B, Michael K, Shaughnessy, M, et al 2007. Testing a Comprehensive Conceptualization of Physical Activity in Stroke Patients. Personal Communication (Manuscript submitted).
- Resnick B, Nigg C. 2003. Testing a theoretical model of exercise behavior for older adults. *Nursing Research*, 52:80–8.
- Resnick B, Orwig D, Magaziner J, et al. 2002b. The effect of social support on exercise behavior in older adults. Clinical Nursing Research, 11:52–70.
- Resnick B, Orwig D, Wehren L, et al. 2005. The Exercise Plus Program for Older Women Post Hip Fracture: Participant Perspectives. *The Gerontologist*, 45:539–44.
- Resnick B, Orwig D, Yu-Yahiro J, et al. 2007. Testing the Effectiveness of the Exercise Plus Program in Older Women Post Hip Fracture. *Annals of Behavioral Medicine*, 34:67–76.
- Resnick B, Orwig D, Zimmerman S, et al. 2005. The Exercise Plus Program for Older Women Post Hip Fracture: Participant Perspectives. *The Gerontologist*, 45:539–44.
- Rhodes RE, Martin AD, Taunton JE. 2001. Temporal relationships of self-efficacy and social support as predictors of adherence in a 6-month strength-training program for older women. *Perception and Motor Skills*, 93:693–703.
- Sallis J, Grossman R, Pinski R, et al. 1986. The development of scales to measure social support for diet and exercise behaviors. *Preventive Medicine*, 16:825–36.

- Sharma M, Sargent L, Stacy R. 2005. Predictors of leisure-time physical activity among African American women. American Journal of Health Behavior. 29:352–9.
- Stewart A, King A, Haskell W. 1993. Endurance exercise and health-related quality of life in 50–65 year-old adults. The Gerontologist, 33:782–9.
- Stewart AL, Hays RD, Ware JE. 1988. The MOS short-form general health survey: Reliability and validity in a patient population. *Medical Care*, 26:724–735.
- Stiggelbout M, Hopman-Rock M, Crone M, et al. 2006. Predicting older adults' maintenance in exercise participation using an integrated social psychological model. *Nursing Research*, 21:1–14.
- Takano T, Nakamura K, Watanabe. 2002. Urban residential environments and senior citizens' longevity in megacity areas: the importance of walkable green spaces. *Journal of Epidemiology and Community Health*, 56:913–8.
- Taylor-Piliae R, Froelicher E. 2005. Measurement properties of Tai Chi exercise self-efficacy among ethnic Chinese with coronary heart disease risk factors: a pilot study. *European Journal Cardiovascular Nursing*, 3:287–94.
- Taylor L, Harris J, Epps C, et al. 2005. Psychometric evaluation of selected pain intensity scales for use with cognitively impaired and cognitively intact older adults. *Rehabilitation Nursing*, 30:55-61.
- Thompson P, Buchner D, Pina IL, et al. 2003. American Heart Association Council on Clinical Cardiology Subcommittee on Exercise, Rehabilitation, and Prevention; American Heart Association Council on Nutrition, Physical Activity, and Metabolism Subcommittee on Physical Activity. Exercise and physical activity in the prevention and treatment of atherosclerotic cardiovascular disease: a statement from the Council on Clinical Cardiology (Subcommittee on Exercise, Rehabilitation, and Prevention) and the Council on Nutrition, Physical Activity, and Metabolism (Subcommittee on Physical Activity). Circulation, 107:3109–16.
- Tinetti ME. 1986. Performance oriented assessment of mobility problems in elderly patients. *Journal of the American Geriatrics Society*, 34:199–206.
- Tinetti ME, Baker DI, Gottschalk M, et al. 1999. Home-based multicomponent rehabilitation program for older persons after hip fracture: a randomized trial. *Archives of Physical Medicine and Rehabilitation*, 80:916–22.
- Tsauo J, Leu W, Chen Y, et al. 2005. Effects on function and quality of life of postoperative home-based physical therapy for patients with hip fracture Archives of Physical Medicine and Rehabilitation, 86:1953–7.
- Turk D, Okifuji A. 1994. Detecting depression in chronic pain patients: adequacy of self-reports. *Behavioral Research and Therapeutics*, 32:9–16.
- Walters S, Munro J. 2004. Using the SF-36 with older adults: a cross-sectional community-based survey. *Age and Ageing*, 30:337–43.
- Ware L, Epps C, Herr K, et al. 2006. Evaluation of the revised faces pain scale, verbal descriptor scale, numeric rating scale, and Iowa pain thermometer in older minority adults. *Pain Management in Nursing*, 7:117–25.
- Wilcox S, Dowda M, Griffin SF, et al. 2006. Results of the first year of active for life: translation of 2 evidence-based physical activity programs for older adults into community settings. *American Journal of Public Health*, 96:1201–9.
- Wilcox S, King A. 2004. The effects of life events and interpersonal loss on exercise adherence in older adults. *Journal of Aging and Physical Activity*, 12:117–30.
- Yu-Yahiro J, Gardner A, Resnick B, et al. 2001. Challenges of designing an exercise program for use with frail elderly hip fracture patients. *The Gerontologist*, 41:57.