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Does self-efficacy mediate functional change in older adults participating in an exercise program after hip fracture? A randomized control trial

Feng-Hang Chang, ScD, MPH, OTR/L,

Assistant Professor at Graduate Institute of Injury Prevention and Control, College of Public Health and Nutrition, Taipei Medical University, Taipei, Taiwan and Post-doctoral Fellow at Health and Disability Research Institute, Boston University School of Public Health, Boston, MA, USA, Tell: 886-22736-1661#6573, Fax: 886-22739-0387, Address: 250 Wu-Hsing Street, Taipei City, Taiwan 110;

Nancy K. Latham, PhD, PT,

Health and Disability Research Institute, Boston University School of Public Health, Boston, MA USA

Pengsheng Ni, MD, MPH, and

Health and Disability Research Institute, Boston University School of Public Health, Boston, MA USA

Alan M. Jette, PhD, MPH, PT, FAPTA

Health and Disability Research Institute, Boston University School of Public Health, Boston, MA USA

Feng-Hang Chang: fhchang@bu.edu

Abstract

Objectives—This study examined whether self-efficacy mediated the effect of the HIP Rehab exercise program on activity limitations in older adults after hip fracture, and whether the mediation effect was different between different gender and age groups.

Design—Randomized controlled trial (RCT)

Setting—Community

Participants—Two hundred and thirty two participants aged 79 ± 9.4 years with hip fracture were randomly assigned to intervention ($n=120$) or attention control ($n=112$) groups.

Correspondence to: Feng-Hang Chang, fhchang@bu.edu.

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Interventions—The 6-month intervention, the HIP Rehab, is a functionally-oriented, home-based exercise program. Data was collected at baseline, post-intervention (6 months), and follow-up (9 months).

Main outcome measure—Activity Measure for Post-Acute Care (AM-PAC)

Results—The mediation effect of the HIP Rehab exercise program on Basic Mobility function through self-efficacy for exercise was significant at 9 months ($\beta_{\text{indirect}}=0.21$). Similarly, the mediation effect of the intervention on Daily Activity function through self-efficacy for exercise was significant at 9 months ($\beta_{\text{indirect}}=0.49$). In subgroup analyses, the mediation effect was significant at 9 months in the younger group (< 79 years old) in comparison to the older group, and was significant in females in comparison to males.

Conclusion—Self-efficacy may play a partial mediating role for the effect on some longer-term functional outcomes in the HIP Rehab intervention. The results suggest that program components that target self-efficacy should be incorporated in the future hip fracture rehabilitation interventions. Age and gender of the targeted participants may also need to be considered when developing interventions.

Keywords

hip fractures; self efficacy; activities of daily living; mobility limitations; aging

Introduction

Hip fracture is an important cause of mortality, morbidity, and serious disability in older adults.^{1, 2} In the U.S., over 258,000 people age 65 and older are hospitalized for hip fracture each year³ and many who survive a hip fracture experience significant functional decline.¹

A variety of rehabilitation interventions have been employed to help individuals with a hip fracture regain their functional independence. Traditional rehabilitation programs are usually delivered within an inpatient rehabilitation hospital, skilled nursing facility, or outpatient clinic setting. After being discharged from a formal post hip fracture rehabilitation program, most people are instructed to continue a home exercise program to maximize and maintain their functional recovery. However, for many adults, maintaining a home exercise program after a formal rehabilitation program ends is very challenging since many are limited by pain, weakness, fear of falling, and low self-efficacy for exercise.^{4, 5}

To address these issues, home-based rehabilitation programs have evoked considerable interest, and their effectiveness has been demonstrated in the hip fracture population. Home-based rehabilitation programs have successfully improved individuals' independence, confidence, function, and health related quality of life (HRQOL).^{6, 7} Zidén et al.,⁸ for example, found that home rehabilitation showed immediate and long-term (1 year post-discharge) effect on improving independence on daily activities (ADL) and instrumental daily activities (IADL), mobility, HRQOL, and balance confidence compared to a conventional care control group.

Within home-based rehabilitation programs, a patient's perceived self-efficacy for exercise has often been considered a critical contributor to achieving rehabilitation outcomes. Self-efficacy is the perception of what one believes s/he has the capability of doing under a variety of circumstances.⁹ Previous studies have suggested that self-efficacy is a strong predictor of adopting and maintaining exercise behaviors in rehabilitation patients.^{10, 11} Rehabilitation programs that have incorporated self-efficacy training, such as verbal persuasion to exercise and self-monitoring, have demonstrated significant impact on outcomes.^{12, 13} Some studies have recognized the full or partial mediating role that self-efficacy plays in initiating and/or maintaining exercise interventions.¹⁴ Resnick, Magaziner, Orwig, & Zimmerman¹², for example, studied older women post hip fracture and proposed that self-efficacy can mediate the relationship between the rehabilitation intervention and outcomes such as exercise adherence, function, and HRQOL. However, the relationship between self-efficacy and rehabilitation outcomes has been shown to be inconsistent across time and studies.^{12, 15} Since low self-efficacy for exercise is particularly an issue in the aging population with hip fracture,^{15, 16} further investigation is needed to understand the relationship between self-efficacy and the effect of exercise interventions.

The Health and Independence Post-Hip Fracture Rehabilitation (Hip Rehab) program is a 6-month, functionally oriented, home exercise program whose goal is to enable participants with a hip fracture continue effective exercise after their formal rehabilitation program ends. The program contains both a progressive exercise and cognitive/behavioral components designed to enhance participants' self-efficacy for exercise. A randomized clinical trial found that compared with controls, the home exercise program resulted in improvement in function after formal hip fracture rehabilitation ended. Improvements in mobility function at 6 and 9 months as measured by the Short Physical Performance Battery (SPPB) were clinically important, whereas improvements in patient-reported basic mobility and daily activity functioning were statistically significant but did not exceed the minimal clinically important difference (4.3 points for the AM-PAC mobility, and 3.7 points for AM-PAC daily activity) when multiple imputation analyses for missing data were conducted.¹⁷

Since the Hip Rehab intervention is a functional oriented intervention, we assumed that the intervention would have a direct impact on participants' functioning. On the other hand, according to Resnick's proposal,¹⁸ self-efficacy may also play a mediating role, in which the effect of the HIP Rehab intervention on functional outcomes might be influenced by participants' level of perceived self-efficacy for exercise. This mechanism needs to be clarified for researchers to understand what key components might explain why the HIP Rehab intervention was efficacious. Demonstrating a full or partial mediating role of self-efficacy for exercise could be used to improve the design of future hip rehabilitation interventions.

The aim of the current study was to examine whether self-efficacy served as a full or partial mediator of the HIP Rehab intervention's effect on functional status among older adults who had fractured their hip. We examined the degree to which the effect of the HIP Rehab intervention on the outcome of activity limitations as measured by the AM-PAC Basic Mobility and Daily Activity measures was lessened by adding the mediating variable into the analysis. If self-efficacy was a significant mediator, we further examined whether the

impact of self-efficacy was different between men versus women and between younger versus older adults in the study. In some literature, age and gender have been shown to be moderators of rehabilitation interventions, and have been shown to be correlates with perceptions of self-efficacy.^{19, 20} For instance, Callaghan²¹ found that those who were women and older had higher self-efficacy beliefs. Therefore, the mediating effect of self-efficacy between people of different ages and gender might vary and were further examined as a secondary aim of this study.

Specifically, the following hypotheses were examined in this study:

1. Self-efficacy will fully or partially mediate the Hip-Rehab intervention effect on Basic Mobility and Daily Activity functioning at the completion of the intervention (6-months from the baseline) and at the 9-month follow-up. In other words, the HIP Rehab program would directly and indirectly improve participants' function through increasing their self-efficacy for exercise.
2. The mediating effects of self-efficacy will be greater among women and younger participants. This hypothesis was based on previous research in which women were found to have benefited from exercise intervention through improved self-efficacy more than men.²⁰ Additionally, since older people generally have more medical problems that may interfere with their physical and cognitive improvement during the intervention,²¹ we believed that it is likely that their self-efficacy and functioning were less improved during the intervention than younger participants.

Methods

This study was a randomized controlled trial with blinded outcome assessment. Data was collected at three time points: baseline, at the completion of the intervention (6-months from the baseline), and follow-up (9-months from the baseline).

Participants

Participants were recruited from acute care and rehabilitation hospitals, skilled nursing facilities, and home care agencies in the greater Boston area. All of the eligible participants had to (1) have a primary diagnosis of hip fracture, (2) be aged 60 years or above, (3) be able to understand and communicate in English, (4) have been recently (in the past 20 months) discharged from rehabilitation services, (5) be able to independently and safely complete sit-to-stand with or without mobility device or assistance, and (6) have at least one functional limitation (determined by the tasks listed on SF-36 physical function scale).

Individuals were excluded from the study if they (1) had serious cognitive deficits; (2) had severe depression; (3) had a terminal illness; (4) had significant pulmonary or cardiovascular contraindications; (5) were legally blind; (6) were currently receiving rehabilitation therapy; (7) lived outside of the study's catchment area in New England; (8) had a bilateral hip fracture; (9) had hip fracture that resulted from a malignancy; (10) had hip fracture more than 2 years before the study; or (11) had a rapidly progressive neurological disease.

Written informed consent was provided by participants and approval for participation was obtained through their primary care provider or orthopedic surgeon. The study was approved by each site's institutional review board.

Randomization and intervention

The recruitment and randomization procedure is demonstrated in the CONSORT flow diagram shown in Appendix 1. Of the 1546 potentially eligible patients we identified, a final sample of 232 people was retained, of whom 120 were randomized to the intervention group, and 112 were randomized to the control group using a computerized central randomization scheme. The stratified block randomization method (with block size 6 to 8) was applied to balance the participants' gender, functional level, and rehabilitation site between the two study groups.

The HIP Rehab program was delivered to the intervention group. This program focused on functional task training including a series of exercises that focused on repeating simple functional tasks based on the Strong for Life program,²² which incorporates cognitive and behavioral strategies designed to maximize participation and adherence. The theoretical approach to this program was based on Social Cognitive theory²³ and the Model of Aging, Control and Motivation.²⁴ The strategies were designed to enhance self-efficacy and outcomes expectancy for exercise as well as exercise motivation. The HIP Rehab program also included standing exercises using steps of varying height, with weighted vests to provide overload.²⁵ A physical therapist (PT) made three home visits and monthly phone calls to instruct the participant, and used cognitive behavioral strategies which included viewing a DVD about the benefits of exercise and overcoming fear of falling, setting specific goals, verbal encouragement and feedback, and self-monitoring progress using an exercise calendar to enhance the participant's self-efficacy for exercise. A DVD version of the HIP Rehab exercise program was also provided. The participants performed the HIP Rehab program three times per week for six months. More details of the program are described in a previous paper.¹⁷

The attention control group was provided with nutrition education for cardiovascular health based on the Dietary Guidelines for Americans.²⁶ Registered dietitians made home visits followed by phone calls and mailings to the participants. The frequency of contact made by dietitians was matched to the frequency of contact made by PTs in the intervention group.

Measures

The primary variables for this study include patient reported Basic Mobility and Daily Activity functioning and perceived self-efficacy.

Functioning—Functioning was measured by the two subscales of the Activity Measure for Post-Acute Care (AM-PAC): Basic Mobility, and Daily Activity.²⁷ The AM-PAC was designed to measure a wide range of functional activities for a diverse group of post-acute care patients across inpatient and community settings.^{27, 28}

Self-efficacy—Self-efficacy was measured by the self-efficacy for exercise (SEE) scale.²⁹ The respondent was asked to rate their confidence to engage in exercise. The SEE scale showed high internal consistency ($\alpha=0.93$) and has been validated in older adults.²⁹

Statistical analysis

The overall tested model is shown in figure 1. We used structural equation modeling (SEM) to examine the degree to which a participant's self-efficacy for exercise mediated the effect of the HIP Rehab intervention on Basic Mobility and Daily Activity functioning based on parallel latent change models.^{30, 31} Then we conducted the multiple-group parallel latent change models to examine whether the intervention/mediation effects were consistent across two demographic subgroups (age (≤ 79 and >79), and gender). The cut-point for participants' age was set at the median of the sample so that we had paired sample size for subgroup comparison.

The model fit was examined by Chi-square test ($p\text{-value} < 0.05$ indicates good model-fit), Comparative fit index (CFI) and Tucker Lewis index (TLI) (value > 0.90 indicates good model-fit), and RMSEA (confidence interval includes 0.05 indicates good model-fit). We applied bias-corrected bootstrap method to examine the statistical significance of the (in)direct and total effects. For these analyses, 5000 bootstrap samples were generated from the sample to create the bootstrap 95% confidence interval of the effects. If the confidence interval didn't include 0, then the effect was deemed to be significant. All the analyses were conducted on SAS (version 9.3) and Mplus (version 6.0).

Results

The baseline characteristics of the sample by study group are shown in table 1. No significant differences were found on these characteristics between the two study groups. Overall, 37 people (15.9%) (20 in the intervention group and 17 in the control group) were lost to follow up at 6 month, and 55 people (21.6%) (26 in the intervention group and 27 in the control group) were lost to follow up at 9 month (see Appendix 1). No significant differences on age, gender, or baseline function were found between people who remained in the study and who lost to follow up.

The AM-PAC and self-efficacy scores across the three assessment points are also shown in Table 1. In the control group, AM-PAC scores remained stable overtime, while in the intervention group, AM-PAC scores showed larger growth from baseline to 6 month and to 9 month. Levels of self-efficacy decreased overtime in the control group, while in the intervention group, the self-efficacy slightly decreased from baseline to 6 month but increased from 6 month to 9 month.

Overall models

The direct and indirect effect coefficients and 95% confidential interval (CI) for the two outcome variables (AM-PAC-Basic Mobility and AM-PAC-Daily Activity) at 6 and 9 months are shown in Table 2. The direct effect refers to the intervention effect on each functional outcome while the indirect effect refers to the extent to which self-efficacy mediates the impact of HIP Rehab on each functional outcome.

Both Basic Mobility and Daily Activity models showed satisfactory model-fit. For Basic Mobility: χ^2 (d.f.=11)=26.78, $p=0.005$; CFI=0.99; TLI=0.95; RMSEA=0.08 (90% CI: 0.04–0.12); Probability of RMSEA $\leq 0.05=0.10$. For Daily Activity: χ^2 (d.f.=11)=14.82, $p=0.19$; CFI=1.00; TLI=0.99; RMSEA=0.04 (90% CI: 0.00–0.08); Probability of RMSEA $\leq 0.05=0.603$.

Basic mobility model

The direct HIP Rehab intervention effect on Basic Mobility function was significant at 6 months ($\beta_{\text{direct}}=1.10$), but was insignificant at 9 months ($\beta_{\text{direct}}=1.27$). On the other hand, the indirect effect of the HIP Rehab intervention on Basic mobility through self-efficacy for exercise was not significant at 6 months ($\beta_{\text{indirect}}=0.06$), but was significant at 9 months ($\beta_{\text{indirect}}=0.21$). Overall, the change in Basic Mobility was mainly due to the direct intervention effect (94.82% during 6 months and 86.39% during 9 months) and partially by the self-efficacy mediation effect (5.17% during 6 months and 14.29% during 9 months).

Daily activity model

The direct Hip Rehab intervention effect on Daily Activity function was significant at 6 months ($\beta_{\text{direct}}=2.79$), but was insignificant at 9 months ($\beta_{\text{direct}}=1.77$). The indirect effect of the HIP Rehab intervention on Daily activity through self-efficacy for exercise was not significant at 6 months ($\beta_{\text{indirect}}=0.12$), but was significant at 9 months ($\beta_{\text{indirect}}=0.49$). The change in Daily Activity functioning was mainly contributed by intervention effect (95.88% during 6 months and 78.31% during 9 months) and partially by the self-efficacy mediation effect (4.12% during 6 months and 21.68% during 9 months).

Group comparison: Age

The results of direct and indirect effects examined in each age and gender group are summarized in table 3. For Basic Mobility, both the direct effect and the indirect effect were only significant at 9 months in the younger age group (individuals ≤ 79 years old: $\beta_{\text{direct}}=1.77$ (84.29% of total effect), $\beta_{\text{indirect}}=0.33$ (15.71% of total effect). No intervention effect was observed in the older group (individuals >79 years old) at any time point. None of the direct and indirect effects were as significant in the Daily Activity model.

Group comparison: Gender

The indirect effect of the HIP Rehab intervention was significant for Daily Activity functioning at 9 months in women ($\beta_{\text{indirect}}=0.69$). No significant indirect effect was found among males even though the intervention effect was significant at 9 months in men on both Basic Mobility and Daily Activity ($\beta_{\text{direct}}=3.74$ and 6.19, respectively).

Discussion

Supporting our first hypothesis, the HIP Rehab intervention showed a significant direct effect at 6 months and partial indirect effect through self-efficacy on enhancing Basic Mobility and Daily Activity functioning at 9 months after randomization into the study. This finding is consistent with Resnick et al.'s proposed model,¹⁸ in which self-efficacy plays a mediation role on the rehabilitation outcomes, even though we only found partial mediation

effect at follow-up assessments. While the majority of previous studies focused on the relationship between self-efficacy and exercise behaviors or impairment-level outcomes, our research appears to be the first study that provides empirical evidence supporting the postulated mediation role that self-efficacy plays in HIP Rehab intervention on functional outcomes.

HIP Rehab is a functionally oriented intervention, which targets improving daily activity and mobility performance. Additionally, it incorporates cognitive-behavioral approaches for enhancing self-efficacy for exercise. Consistent with the previous study, our study demonstrated that the HIP Rehab intervention had statistically significant effects on functional outcomes and self-efficacy in older adults.¹⁷ While this study particularly focused on self-reported activity limitation outcomes, further investigation of the mediation effect on physical performance mobility outcomes such as balance, gait speed, and chair rise may be useful since these outcomes have demonstrated meaningful improvement during the intervention reported in the earlier study.¹⁷

We were in fact surprised to see that the mediation effect of self-efficacy was significant at 9 months but not at 6 months. We suspect that the delayed mediation effect seen in this sample may be due to the change of self-efficacy that occurred during the course of follow-up. In the intervention group, self-efficacy slightly decreased at 6 months but returned to baseline levels at the 9 month follow-up assessment which resulted in no significant change of score throughout the time. In contrast, the control group's self-efficacy score declined at each time interval, with a significant decline in self-efficacy taking place from baseline to 9 month follow up. Resnick et al.¹² has suggested that individuals' confidence to engage in exercise may decline following exposure to an exercise intervention as they started to recognize what needs to be done in the program. Participants in both groups might also experience a decline in self-efficacy as they began to engage in more complex activities in their home and community and discovered that they had significant new physical limitations as a result of their hip fracture. The difference in the pattern of change in self-efficacy between the two groups indicates that the intervention had played a significant role to protect against the loss of self-efficacy in the recovery process. Control participants lost confidence for exercise gradually, and therefore may not be able to rebuild their belief that they are able to do exercise consistently.³² The maintenance of self-efficacy in the intervention group might be due to both the participants' success with the exercise training itself (which was shown in the improved AM-PAC and SPPB scores) as well as the cognitive-behavioral strategies.³³ Further exploration about the possible factors that contribute to the maintenance of self-efficacy in older adults will be needed in future research.

The loss of self-efficacy for exercise by older people after hip fracture has been recognized before. This has been associated with older people's difficulty initiating and maintaining exercise activity on their own.¹⁸ The current findings highlight the protective role that the HIP Rehab intervention played in preventing the decline of self-efficacy among older people and how this appeared to influence the increase of the participants' mobility and basic daily activity performance.

The literature on physical activity highlights the challenge of interventions for promoting long-term maintenance of exercise behaviors, which require individuals to actively utilize the skills and strategies that they learned from the intervention.³⁴ Self-efficacy, according to Nigg et al's Physical Activity maintenance (PAM) model³⁴ and existing empirical evidence,³⁵ has critical influence on long-term exercise maintenance. The role of self-efficacy in exercise maintenance may explain our results and suggest that after the self-efficacy was developed through the intervention, participants may be more likely to continue the training themselves and feel confident in performing functional activities.

In the subgroup comparisons, this study indicates that the intervention seems to be more effective both directly and indirectly through self-efficacy on improving mobility in the younger group. This finding is not surprising since older adults face barriers such as poorer health and lower self-efficacy for exercise.⁴ Previous studies have identified age to be a determinant of declining physical activity and lower exercise adherence.^{19, 20} All these challenges may limit the intervention effect and may explain why the direct and indirect intervention effect were restricted in the relatively older group.

Comparing men and women, the mediation effect was only significant on daily life in women. Even though the male participants had significantly higher self-efficacy for exercise than women at baseline ($t=-2.71$, $p=0.01$), female participants showed greater improvement in self-efficacy. During our intervention, female participants had developed self-efficacy, with which they could carry on exercise even after the intervention ended and showed significant functional improvement at the 9-month follow-up assessment. This result is aligned with Dolansky's study,²⁰ in which women participants showed lower self-efficacy at baseline, but improved as much and even more than male participants after rehabilitation.²⁰ Our findings highlighted the potential psychological difference between males and females receiving an exercise intervention. The gender difference can be a critical element for clinicians to consider while designing the intervention.

Study Limitations

There are a few limitations in this study. First, we only included participants who met the inclusion criteria. Thus, the study findings may not be generalized to individuals with significant cognitive deficits, severe depression, or other severe medical conditions. Even for those who met the inclusion criteria, about half of the subjects refused to participate, died, or were unable to be reached for follow-up assessment, which may also restrict the study's generalizability. There are no data available on those subjects who refused to participate or for the other reasons for exclusion from the study. Second, some lost to follow up occurred in the longitudinal process of data collection. However, no significant difference was found between the remained and the lost samples. Third, we only followed up the participants until 3 months after intervention. The longer follow-up can be done in future studies to examine the long-term intervention and mediation effect.

Conclusion

This study contributes to understanding how the HIP Rehab intervention works in enhancing older adults' functional outcomes. While the HIP Rehab program demonstrated a direct impact on improving function after formal hip fracture rehabilitation ended, the findings indicate that self-efficacy may play a partial mediating role for the effect on some longer-term functional outcomes in the HIP Rehab intervention. The findings do not only help explain the mechanism of this intervention program, but also have implications for the design of future interventions by demonstrating the significance of self-efficacy on the maintenance of intervention effect. Researchers may consider incorporating self-efficacy in rehabilitation programs that aim to improve functional outcomes. Moreover, it should be noted that the mediating effect of self-efficacy on Basic Mobility was significant only in participants who were 79 years old or younger, and the mediating effect of self-efficacy on Daily Activity was significant only in women. These findings suggest that future interventions may need to consider the difference between these subpopulations and tailor interventions to their needs. For example, for women and older people, enhancing their self-efficacy for exercise may be a particularly effective a focus in the rehabilitation program. Further investigations of the impact of other clinical, social, and demographic characteristics on the mediation effect will be needed to better understand how these variables interact with the intervention.

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Abbreviations

ADL	daily activities
AM-PAC	Activity Measure for Post-Acute Care
CFI	Comparative fit index
HIP Rehab	Post-Hip Rehabilitation
HRQOL	health related quality of life
IADL	instrumental daily activities
PAM	Physical Activity maintenance
SEE	self-efficacy for exercise
TLI	Tucker Lewis index

References

1. Roth T, Kammerlander C, Gosch M, Luger TJ, Blauth M. Outcome in geriatric fracture patients and how it can be improved. *Osteoporos Int.* 2010; 21(Suppl 4):S615–9. [PubMed: 21058001]
2. Johansen A, Mansor M, Beck S, Mahoney H, Thomas S. Outcome following hip fracture: Post-discharge residence and long-term mortality. *Age Ageing.* 2010; 39(5):653–6. [PubMed: 20587442]

3. Stevens JA, Rudd RA. The impact of decreasing U.S. hip fracture rates on future hip fracture estimates. *Osteoporos Int.* 2013; 24(10):2725–8. [PubMed: 23632827]
4. Schutzer KA, Graves BS. Barriers and motivations to exercise in older adults. *Prev Med.* 2004; 39(5):1056–61. [PubMed: 15475041]
5. Herrick C, Steger-May K, Sinacore DR, Brown M, Schechtman KB, Binder EF. Persistent pain in frail older adults after hip fracture repair. *J Am Geriatr Soc.* 2004; 52(12):2062–8. [PubMed: 15571543]
6. Crotty M, Whitehead CH, Gray S, Finucane PM. Early discharge and home rehabilitation after hip fracture achieves functional improvements: A randomized controlled trial. *Clin Rehabil.* 2002; 16(4):406–13. [PubMed: 12061475]
7. Tsao J, Leu W, Chen Y, Yang R. Effects on function and quality of life of postoperative home-based physical therapy for patients with hip fracture. *Arch Phys Med Rehabil.* 2005; 86(10):1953–7. [PubMed: 16213237]
8. Zidén, Lena; Kreuter, Margareta; Frändin, Kerstin. Long-term effects of home rehabilitation after hip fracture – 1-year follow-up of functioning, balance confidence, and health-related quality of life in elderly people. *Disability & Rehabilitation.* 2010; 32(1):18–32. [PubMed: 19925273]
9. Bandura, A. Self-efficacy: The exercise of control. New York: W.H. Freeman and Company; 1997.
10. Schwarzer R, Luszczynska A, Ziegelmann JP, Scholz U, Lippke S. Social-cognitive predictors of physical exercise adherence: Three longitudinal studies in rehabilitation. *Health Psychology.* 2008; 27(1):S54–63. [PubMed: 18248106]
11. Millen JA, Bray SR. Promoting self-efficacy and outcome expectations to enable adherence to resistance training after cardiac rehabilitation. *J Cardiovasc Nurs.* 2009; 24(4):316–27. [PubMed: 21206354]
12. Resnick B, D'Adamo C, Shardell M, Orwig D, Hawkes W, Hebel JR, et al. Adherence to an exercise intervention among older women post hip fracture. *J Clin Sport Psychol.* 2008; 2(1):41–56. [PubMed: 20428489]
13. Resnick B. Testing the effect of the WALC intervention on exercise adherence in older adults. *J Gerontol Nurs.* 2002; 28(6):40–9. [PubMed: 12071273]
14. Anderson ES, Winett RA, Wojcik JR, Williams DM. Social cognitive mediators of change in a group randomized nutrition and physical activity intervention: Social support, self-efficacy, outcome expectations and self-regulation in the guide-to-health trial. *J Health Psychol.* 2010; 15(1):21–32. [PubMed: 20064881]
15. Resnick B, Orwig D, D'Adamo C, Yu-Yahiro J, Hawkes W, Shardell M, et al. Factors that influence exercise activity among women post hip fracture participating in the exercise plus program. *Clin Interv Aging.* 2007; 2(3):413–27. [PubMed: 18044192]
16. Visschedijk JH, Caljouw MA, van Balen R, Hertogh CM, Achterberg WP. Fear of falling after hip fracture in vulnerable older persons rehabilitating in a skilled nursing facility. *J Rehabil Med.* 2013; 46(3):258–63. [PubMed: 24284784]
17. Latham NK, Harris BA, Bean JF, Heeren T, Goodyear C, Zawacki S, et al. Effect of a home-based exercise program on functional recovery following rehabilitation after hip fracture: A randomized clinical trial. *JAMA.* 2014; 311(7):700–8. [PubMed: 24549550]
18. Resnick B, Magaziner J, Orwig D, Zimmerman S. Evaluating the components of the exercise plus program: Rationale, theory and implementation. *Health Educ Res.* 2002; 17(5):648–58. [PubMed: 12408209]
19. Thomas S, Halbert J, Mackintosh S, Quinn S, Crotty M. Sociodemographic factors associated with self-reported exercise and physical activity behaviors and attitudes of south australians: Results of a population-based survey. *J Aging Health.* 2012; 24(2):287–306. [PubMed: 21956097]
20. Dolansky MA, Stepanczuk B, Charvat JM, Moore SM. Women's and men's exercise adherence after a cardiac event. *Res Gerontol Nurs.* 2010; 3(1):30–8. [PubMed: 20128541]
21. Callaghan D. Healthy behaviors, self-efficacy, self-care, and basic conditioning factors in older adults. *J Community Health Nurs.* 2005; 22(3):169–78. [PubMed: 16083404]
22. Jette AM, Lachman M, Giorgetti MM, Assmann SF, Harris BA, Levenson C, et al. Exercise--it's never too late: The strong-for-life program. *Am J Public Health.* 1999; 89(1):66–72. [PubMed: 9987467]

23. Bandura A. Social cognitive theory. *Annals of child development*. 1989; 6:1–60.
24. Lachman ME, Jette A, Tennstedt S, Howland J, Harris BA, Peterson E. A cognitive-behavioural model for promoting regular physical activity in older adults. *Psychol Health Med*. 1997; 2(3): 251–61.
25. Bean JF, Herman S, Kiely DK, Frey IC, Leveille SG, Fielding RA, et al. Increased velocity exercise specific to task (InVEST) training: A pilot study exploring effects on leg power, balance, and mobility in community-dwelling older women. *J Am Geriatr Soc*. 2004; 52(5):799–804. [PubMed: 15086665]
26. U.S. Department of Health and Human Services and U.S. Department of Agriculture. Dietary guidelines for americans. 6. Washington, D.C: Government Printing Office; 2005.
27. Haley SM, Coster WJ, Andres PL, Ludlow LH, Ni P, Bond TL, et al. Activity outcome measurement for postacute care. *Med Care*. 2004; 42(1 Suppl):I49–61. [PubMed: 14707755]
28. Haley SM, Andres PL, Coster WJ, Kosinski M, Ni P, Jette AM. Short-form activity measure for post-acute care. *Arch Phys Med Rehabil*. 2004; 85(4):649–60. [PubMed: 15083443]
29. Resnick B, Jenkins LS. Testing the reliability and validity of the self-efficacy for exercise scale. *Nurs Res*. 2000; 49(3):154–9. [PubMed: 10882320]
30. Willoughby M, Vandergrift N, Blair C, Granger DA. A structural equation modeling approach for the analysis of cortisol data collected using pre–post–post designs. *Struct Equ Modeling*. 2007; 14(1):125–45.
31. Mun EY, von Eye A, White HR. An SEM approach for the evaluation of intervention effects using pre-post-post designs. *Struct Equ Modeling*. 2009; 16(2):315–37. [PubMed: 20228953]
32. Resnick, B. Chapter 10: The theory of self-efficacy. In: Smith, MJ.; Liehr, PR., editors. *Middle Range Theory for Nursing*. 3. Springer Publishing Company, Inc; 2013. p. 183-204.
33. Resnick B, Orwig D, Wehren L, Zimmerman S, Simpson M, Magaziner AJ. The exercise plus program for older women post hip fracture: Participant perspectives. *Gerontologist*. 2005; 45(4): 539–44. [PubMed: 16051917]
34. Nigg CR, Borrelli B, Maddock J, Dishman RK. A theory of physical activity maintenance. *Appl Psychol*. 2008; 57(4):544–60.
35. McAuley E, Jerome GJ, Elavsky S, Marquez DX, Ramsey SN. Predicting long-term maintenance of physical activity in older adults. *Prev Med*. 2003; 37(2):110–8. [PubMed: 12855210]

Appendix 1

CONSORT 2010 Flow Diagram

Figure 1.

The tested model of the direct and indirect intervention effects on functional outcomes measured by the AM-PAC.

Direct effect: The direct intervention effect on AM-PAC

Indirect effect (Mediation effect): The intervention effect on AM-PAC through self-efficacy

Table 1

Characteristics of the sample (N=232)

Variable	Control (n=112)	Exercise (n=120)
	Mean (SD)	
Age	78.9 (9.4)	77.2 (10.2)
Months since fracture	8.6 (4.8)	9.5 (5.2)
Mini-Mental State Exam	28.7 (2)	28.8 (1.7)
Geriatric Depression Scale	2.4 (1.9)	2.6 (2.0)
AMPAC		
Baseline		
Basic Mobility	55.7 (7.1)	56.1 (7.3)
Daily Activity	58.0 (15.0)	57.2 (13.8)
At 6 month		
Basic Mobility	56.6 (8.1)	58.1 (7.9)
Daily Activity	58.6 (15.3)	61.3 (15.7)
At 9 month		
Basic Mobility	56.7 (7.6)	59.5 (9.3)
Daily Activity	59.0 (14.9)	63.0 (15.9)
Self-efficacy for exercise		
Baseline	64.4 (16.9)	62.2 (19.4)
At 6 month	58.7 (21.5)	59.6 (19.4)
At 9 month	58.1 (20.2)	63.2 (18.3)
	Number (%)	
Gender (Female)	77 (68.8)	83 (69.2)
Race (White)	97 (86.6)	109 (90.8)
Most recent therapy site		
Outpatient	42 (42.9)	57 (47.5)
Inpatient	2 (1.8)	1 (0.8)
Home	62 (55.4)	62 (51.7)

Table 2

Mediating effect of self-efficacy on AM-PAC

	Basic mobility-6m	Basic mobility-9m	Daily activity-6m	Daily activity-9m
Direct	1.10 (0.04, 2.19)*	1.27 (−0.02, 2.58)	2.79 (0.42, 5.09)*	1.77 (−0.67, 4.15)
Indirect	0.06 (−0.10, 0.31)	0.21 (0.02, 0.52)*	0.12 (−0.11, 0.76)	0.49 (0.02, 1.27)*
Total	1.16 (0.08, 2.27)*	1.47 (0.17, 2.83)*	2.91 (0.53, 5.28)*	2.26 (−0.30, 4.80)

Notes: Variables shown are regression coefficient (95% CI)

* 95% CI does not contain 0

Table 3

Subgroup comparison of self-efficacy on Basic Mobility and Daily Activity

6-months change			9-months change	
Basic Mobility				
Age	Old (>79 yrs)	Young (≤ 79 yrs)	Old (>79 yrs)	Young (≤ 79 yrs)
Direct	1.07 (−0.46, 2.49)	0.95 (−0.57, 2.54)	0.43 (−1.41, 2.27)	1.77 (0.02, 3.84)*
Indirect	0.08 (−0.25, 0.66)	0.05 (−0.06, 0.50)	0.11 (−0.12, 0.62)	0.33 (0.02, 0.97)*
Total	1.15 (−0.48, 2.66)	1.00 (−1.36, 2.34)	0.54 (−0.50, 2.58)	2.10 (0.30, 4.24)*
Daily Activity				
Age	Old (>79 yrs)	Young (≤ 79 yrs)	Old (>79 yrs)	Young (≤ 79 yrs)
Direct	1.81 (−3.15, 13.23)	2.44 (−1.38, 5.81)	0.65 (−0.61, 4.47)	1.68 (−2.15, 5.43)
Indirect	0.20 (−0.52, 1.65)	−0.01 (−0.73, 0.60)	0.22 (−0.17, 1.31)	0.88 (−0.01, 2.64)
Total	2.01 (−0.61, 4.85)	2.43 (−1.86, 3.63)	0.87 (−1.36, 5.82)	2.56 (−1.56, 6.56)
Basic Mobility				
Gender	Male	Female	Male	Female
Direct	1.98 (−0.35, 4.32)	0.86 (−0.29, 2.01)	3.74 (0.77, 6.75)*	0.55 (−0.92, 2.00)
Indirect	−0.21 (−1.45, 0.15)	0.11 (−0.03, 0.51)	−0.35 (−2.19, 0.49)	0.15 (−0.12, 0.57)
Total	1.77 (−0.55, 4.17)	3.39 (−0.19, 2.10)	0.97 (0.50, 6.62)*	0.70 (−0.75, 2.09)
Daily Activity				
Gender	Male	Female	Male	Female
Direct	3.38 (−1.68, 8.31)	2.02 (−0.55, 4.48)	6.19 (0.23, 11.34)*	−0.14 (−3.02, 2.70)
Indirect	0.13 (−0.62, 2.65)	0.39 (−0.06, 1.50)	−0.55 (−4.30, 1.03)	0.69 (0.07, 1.77)*
Total	3.51 (−1.22, 8.31)	2.41 (−0.25, 4.99)	6.74 (0.20, 10.40)*	0.55 (−2.40, 3.34)

Notes: Variables shown are regression coefficient (95% Confidence interval (CI))

* 95% CI does not contain 0