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Original Article

Validation of a Prediction Model for Likelihood of Fall Prevention Actions in Community-Dwelling Older Adults: Application of the Health Belief Model

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SUMMARY

Background: It is important to understand the elderly's subjective beliefs, attitudes, and behaviors regarding fall prevention. This study used the Health Belief Model (HBM) as a theoretical framework to develop a prediction model for the likelihood of fall prevention actions in community-dwelling older adults.

Methods: Subjects were 704 elderly in the communities of a county in northern Taiwan. Descriptive analysis, item analysis, factor analysis and Pearson's correlations were used for the statistical analysis. Structural equation modeling was used to verify the fit of the overall model and the amount of variance explained.

Results: The results showed good overall model fit. *Perceived severity* ($\beta = 0.144$, $p < 0.01$), *Perceived benefit* ($\beta = 0.109$, $p < 0.05$), *Self-efficacy* ($\beta = 0.408$, $p < 0.01$), and *Cue to action* ($\beta = 0.212$, $p < 0.01$) can effectively predict the likelihood of the community elderly taking action to prevent falls. *Self-efficacy* had the largest influence, followed by *Cue to action, Perceived severity,* and *Perceived benefit*. The overall predictive power was 39.0%.

Conclusion: The results provide evidence that the HBM is suitable for exploring the likelihood of fall prevention actions by community-dwelling older adults and identifying the significant influencing factors and the influence paths between factors. Understanding the impact process can help in the development of more effective interventions.

1. Introduction

With the aging of the world's population, fall prevention for the elderly has become an important issue in public health. Falling not only has a high prevalence and recurrence rate, but is also an important factor causing serious injuries and deaths in the elderly.[1,2] According to relevant reports from the World Health Organization, the global incidence of falls in the elderly over 65 years of age is between 28–35%, and the incidence of falls in the elderly over 70 years of age has increased to 32–42%. It has been pointed out that the incidence of falls rises with increasing age, and differs from country to country.[2–5]

Falls in elderly people not only harm their physical and mental health, but may also increase the burden of care manpower and medical costs of the family. It is known that falls and fear of falls are common in the elderly, and have a negative impact on their physical and mental health and quality of life.[1,6] The serious consequences of falls, in addition to bringing a huge economic burden to the family, also increase medical expenses for society as a whole.[7,8] Therefore, reducing the incidence of falls and effectively preventing their occurrence has become an important global health promotion issue.[9–12]

The effectiveness of fall prevention interventions mainly depends on the participation and compliance of the elderly in intervention actions.[13] However, the actual participation rate of the elderly in community-based fall prevention actions is very low.[14,15] The lack of fall prevention knowledge is the main barrier.[13] Another common factor affecting the elderly's participation in and acceptance of fall prevention actions is their physical environment, and 30–50% of barriers to prevention can be classified as physical environmental obstacles.[16] According to Hill et al.,[17] the factors that affect whether the elderly in the community participate in multi-factor fall prevention programs include the perceived effectiveness of intervention activities, the perceived risk of falls, the perceived fall injury, and the absence of handrails when going up and down stairs. For interventions to be successful, it is important to study the elderly's subjective beliefs, attitudes, and behaviors about fall prevention, and guide or change them, to enhance the elderly's participation in and acceptance of fall prevention actions.

In the past, research on the issue of falls in the elderly rarely explored the factors that influence whether they adopt fall prevention actions from the perspective of community-dwelling elderly.[18,19] Studies related to healthy behaviors have pointed out that appropriate health behavior theories can help systematically analyze the causes of complex behaviors and provide specific guidance in practical work.[20–24] The four constructs of *Perceived susceptibility* (cor-

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responding to the elderly's fall prevalence rate), *Perceived severity* (corresponding to the elderly's fall-related injuries), *Perceived benefit* (corresponding to the benefits of fall prevention), and *Perceived barrier* (corresponding to the effects of participation of fall prevention) in HBM[25] are in line with the topic of this study. Therefore, this study used the HBM as a theoretical framework to develop a prediction model for the likelihood of fall prevention actions in community-dwelling older adults. The study aimed to collect more extensive and in-depth personal opinions on whether community elderly would participate in and accept fall prevention actions, which can be used for reference and planning to promote intervention actions for fall prevention in community-dwelling elderly.

2. Methods

2.1. Participants

This study targeted community-dwelling older adults from community care centers in a city in Northern Taiwan. The inclusion criteria were: (1) being over 65 years old; (2) able to express personal opinions in Mandarin or Taiwanese; (3) willingness to participate in the study and provide written informed consent.

2.2. Measurements

2.2.1. Structured questionnaire design

The content of the questionnaire included (1) sociodemographic characteristics: age, gender, educational level, marital status, living status, fall experience (past year), chronic illness, and perceived fall risk; (2) the likelihood of the elderly taking preventive actions. The questionnaire was composed of 7 dimensions with 30 items according to the HBM shown in Table 1. The questions referring to each measurement variable in the questionnaire were developed using the Q-statement of Chen et al.[14] The sample statement in *Perceived susceptibility* was: "I believe that I am old now and often react slowly, which might make me accidentally bump into objects and stumble." A 5-point Likert scale was used as the scoring method, ranging from 5 (strongly agree) to 1 (strongly disagree). A higher score indicates higher likelihood of taking fall prevention actions.

2.2.2. Questionnaire pre-test

After the first draft of the questionnaire was completed, two experts with experience in health promotion and fall prevention performed content validity checks on the semantic understanding of the sentence. Fifty-one elderly who met the inclusion criteria were recruited for a once-off pre-test (the questionnaires for those interviewees unable to read by themselves were completed by trained interviewers on their behalf). The reliability of the pre-test questionnaire was verified with internal consistency reliability, using the number of subscales and total scale questions for each measurement variable. The Cronbach's α value was reported in Table 1. All the Cronbach's α values were greater than 0.7, showing they all had satisfactory internal consistency.

The factor loadings of each item were between 0.613–0.955 (> 0.5), the variance explained in each study variable was between 50.80–86.70% (> 50%), the KMO value was between 0.555–0.736 (> 0.5), and Bartlett's test of sphericity was significant ($p < 0.001$), showing that this pre-test questionnaire has good construct validity.

2.2.3. Formal survey

After the pre-test analysis was completed, the elderly who met the inclusion criteria were recruited to participate in the formal survey. A cross-sectional quantitative questionnaire survey was conducted from March to September 2015 by purposive sampling. A total of 704 valid questionnaires were completed. To ensure the consistency of the testing process, the community liaison assisted in the communication and explanation of the research survey to the participants, and then the interviewers assisted the participants during the interviews and when filling out the questionnaires. The participants were permitted to withdraw from the study at any time. This study was approved by the Institutional Review Board of Tri-Service General Hospital, Taiwan (TSGHIRB2-103-05-122).

2.3. Statistical analysis

The data analysis was performed with SPSS 20.0 and AMOS 20.0 software packages. Descriptive analysis was used to describe the distribution of the sociodemographic characteristics of participants. Standard deviation, skewness coefficient, and kurtosis coefficient were used for univariate normality test.[26] Mardia's coefficient and the number of observational variables were used for the multivariate normality test.[27] The relevance of the questions in the item analysis and the factor analysis method were used to evaluate the suitability of each item in the questionnaire. Cronbach's α and factor analysis were used to evaluate the reliability and validity. Pearson's correlation was used for the correlation analysis between research variables. Structural equation modeling (SEM) was used to verify the fit of the overall model, confirm the amount of variance explained, and understand the overall relationship path model.

3. Results

The participants' sociodemographic characteristics are shown in Table 2.

3.1. Normality test

The standard deviation of each measurement item was between 0.570–1.265 (not more than +3 and less than -3), the skewness coefficient was between -1.373 – -0.304 (< 3), and the kurtosis coefficient was -1.241–4.760 (< 10), the Mardia coefficient was 357.931 < 960 (the number of observational variables was 30), which shows the observational variables had a multivariate normal distribution, so the maximum likelihood estimation method could be used to perform the model fit test.

3.2. Question fit assessment

The correlation coefficient of the total score of each question was between 0.660–0.941 (> 0.3, $p < 0.01$); the common extraction value was between 0.440–0.889 (> 0.3), indicating that the content of each question was good.

Table 1
Pre-test questionnaire reliability analysis.

Constructs	Number of items	Cronbach's α
Perceived susceptibility	7	0.867
Perceived severity	5	0.854
Perceived benefit	3	0.923
Perceived barrier	4	0.723
Cue to action	4	0.879
Self-efficacy	4	0.747
Likelihood of action	3	0.710
Total	30	0.863

Table 2
Sociodemographic characteristics of participants.

Variable	Number	(%)	(Mean ± SD)
Age	704		74.57 ± 7.03 (65–102)
Gender			
Female	498	(70.71)	
Male	206	(29.26)	
Education level			
Illiterate	143	(20.31)	
Literacy (self-study)	44	(6.25)	
Elementary school	281	(39.91)	
Junior high school	103	(14.63)	
High school	94	(13.35)	
College and above	39	(5.54)	
Marital status			
Single	264	(37.50)	
Partner	440	(62.50)	
Living status			
Solitary	106	(15.06)	
With spouse	222	(31.25)	
With children	173	(24.57)	
Three generations	203	(28.83)	
Falls have occurred in the past year?			
Yes	209	(29.69)	
No	495	(70.31)	
Hypertension			
Yes	348	(49.43)	
No	356	(50.57)	
Heart disease			
Yes	121	(17.19)	
No	583	(82.81)	
Perceived the risk of falls?			
Yes	421	(59.80)	
No	283	(40.20)	

3.3. Questionnaire reliability and validity

The Cronbach's α value of each research variable in Table 3 ranged from 0.755 to 0.912, and the Cronbach's α value of the total scale was 0.818 (> 0.7), indicating that the questionnaire achieved good internal consistency. The factor loading of each question was between 0.633–0.943 (> 0.5), the explanatory variation of each study variable was between 50.57–85.06% (> 50%), the KMO value was between 0.689–0.882 (> 0.5), and Bartlett's test of sphericity was significant ($p < 0.001$), showing that the questionnaire had good construct validity. The questionnaire items and grammar were revised by pre-test participants and experts with relevant experience, which confirmed the content validity.

Table 3
Reliability and validity analysis (n = 704).

Construct	Items	Cronbach's α	Factor loading	Explained variance (%)
Perceived susceptibility	7	0.836	0.633–0.763	50.57
Perceived severity	5	0.811	0.728–0.843	67.96
Perceived benefit	3	0.912	0.888–0.942	85.06
Perceived barrier	4	0.755	0.680–0.831	57.81
Cue to action	4	0.770	0.667–0.836	59.10
Self-efficacy	4	0.766	0.731–0.807	79.27
Likelihood of action	3	0.879	0.846–0.943	81.45

3.4. Correlation analysis

Table 4 shows that *Perceived severity*, *Perceived benefit*, *Cue to action*, *Self-efficacy* and *Likelihood of action* all had statistically significant positive correlations, and *Perceived barrier* and *Likelihood of action* were significantly negatively correlated. *Perceived susceptibility* and *Likelihood of action* failed to reach a statistically significant correlation.

3.5. Measurement model fit test

The measurement model fit indices were all good (GFI = 0.920, AGFI = 0.903, CFI = 0.949, NFI = 0.913, TLI = 0.942, all greater than 0.9) and the residuals were good (SRMR = 0.048, RMSEA = 0.043, all less than 0.08), and conformed to the principle of simplicity (PGFI = 0.760 > 0.5, and CN = 347 > 200), which means that the measurement model was acceptable, so further structural model verification could be performed.[26]

3.6. Structural model verification

The fit of the structural model to the observed data was good: χ^2/df = 2.382, GFI = 0.916, AGFI = 0.900, CFI = 0.944, NFI = 0.908, TLI = 0.938, all greater than 0.9; SRMR = 0.054, RMSEA = 0.044, all less than 0.08, indicating that the residuals were good; PGFI = 0.767 > 0.5, and CN = 331 > 200, which means that the principle of simplicity was met.[26]

Figure 1 shows the relation among the variables of SEM results.

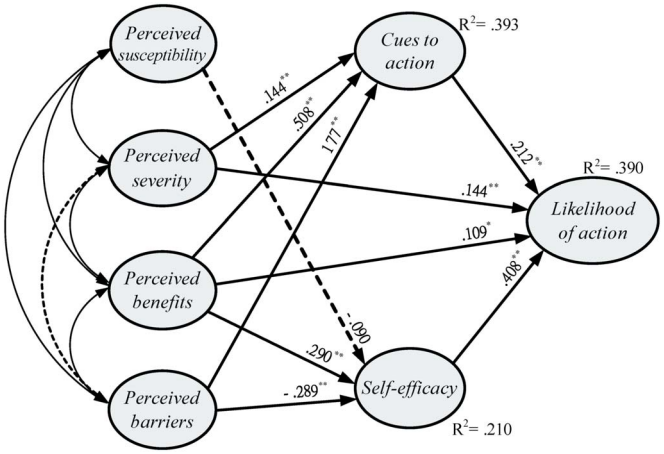

Figure 1. Structural model results. * $p < 0.05$, ** $p < 0.01$; Dotted line: $p > 0.05$.

Table 4
Pearson's correlation analysis.

Construct	1	2	3	4	5	6	7
1. Likelihood of action	1						
2. Perceived susceptibility	-0.019	1					
3. Perceived severity	0.269**	0.234**	1				
4. Perceived benefit	0.391**	0.084*	0.394**	1			
5. Perceived barrier	-0.135**	0.375**	-0.029	-0.096*	1		
6. Cue to action	0.433**	0.048	0.306**	0.508**	-0.140**	1	
7. Self-efficacy	0.464**	-0.155**	0.124**	0.258**	-0.252**	0.384**	1

* $p < 0.05$, ** $p < 0.01$.

Table 5 shows *Perceived severity*, *Perceived benefit*, *Cue to action*, and *Self-efficacy* all had a positive and significant influence on *Likelihood of action*. *Self-efficacy* had the largest influence, followed by *Cue to action*, then *Perceived severity*, and *Perceived benefit*. The predictive power of the overall model was 39.0%.

For the predictive power of *Cue to action*, Table 5 shows that *Perceived severity* and *Perceived benefit* both had a positive and significant influence on *Cue to action*. *Perceived barrier* had a significant negative impact on *Cue to action*. The above three variables had a predictive power of 39.3% for *Cue to action*.

For the predictive power of *Self-efficacy*, Table 5 shows that *Perceived benefit* had a significant positive impact on *Self-efficacy*; and *Perceived barrier* had a significant negative impact on *Self-efficacy*. *Perceived susceptibility* only had a negative influence on *Self-efficacy*, but did not reach statistical significance. In summary, the predictive power of the above variables on *Self-efficacy* was 21.0%.

4. Discussion

This study used *Health belief*, *Cue to action*, and *Self-efficacy* to develop a prediction model suitable for the likelihood of the elderly in the community to take fall prevention actions. It showed that the overall model fit was good. *Perceived severity*, *Perceived benefit*, *Cue to action*, and *Self-efficacy* can effectively predict the likelihood of the community elderly taking actions to prevent falls. *Self-efficacy* had the largest influence, followed by *Cue to action*, *Perceived severity*, and *Perceived benefit*; the overall predictive power was 39.0%, and the predictive power of this study(22–37%) was better than the predictive power of preventive screening and health behavior in previous research.[28–30]

The SEM analysis showed that, *Self-efficacy* had the greatest influence on the elderly's likelihood of taking fall prevention actions. The meta-analysis of Berkiten et al.[31] also showed that *Self-efficacy* can significantly predict the likelihood of women performing breast self-examination behaviors. This study's results also confirm that *Self-efficacy* will significantly positively affect and predict healthy behavior among the elderly. These show that the community elderly can consciously take action to prevent falls, such as slowing down when changing posture, exercising regularly, paying attention to drug side effects and paying attention to safety in the bathroom. When elderly people are involved in fall prevention or falls efficacy intervention activities, their *Self-efficacy* should be actively enhanced to increase the possibility that they will take fall prevention actions.[32–35]

Research also shows that Cue to action predicts the likelihood of healthy behavior the elderly people.[36,37] Li et al.[22] pointed out that *Cue to action* was generally positively correlated with risk-reduction behaviors for fall prevention. The results of this study show that the predictive power of *Cue to action* for the community-dwelling elderly to take fall prevention actions is 39.3%. This indicates that fear of fall injury, special attention at the previous falling sites, others' falling experiences or reminders and participation in elderly fall prevention courses can prompt the community elderly consciously take action to prevent falls. In the future, it will be necessary to strengthen the elderly's fall prevention advocacy activities in the community. In addition to providing information on the severity of the fall and health education on the effectiveness of fall prevention, it is also necessary to reduce the negative factors affecting fall prevention to improve the possibility of the elderly in the community to take preventive actions.

Previous studies showed that *Perceived benefit* in Health belief is the most important factor affecting whether the elderly adopt healthy behaviors, followed by *Perceived barrier* and *Perceived severity*, while *Perceived susceptibility* had the lowest impact.[28–30] In contrast, this study showed that *Perceived severity* was the most important factor affecting whether the elderly community take preventive actions against falls. This illustrates that the community elderly will take action to prevent falls due to the physical, psychological, life and family impact caused by falls. *Perceived benefit* was observed as the second most important factor in this study. The results discrepancy explained that community elderly will take action to prevent falls in order to make themselves physically and mentally healthy and to reassure their families and reduce their burden. However, these reasons are less influential than those in *Perceived severity* when the elderly take preventive measures.

Perceived susceptibility and Perceived barrier had no direct impact, which means that when the elderly in the community are facing the health promotion issue of "fall prevention," the most important thing they care about is the injuries caused by falls, followed by the benefits that fall prevention can bring them, their families, and those around them. This is consistent with the perspectives of Chen et al.[14] The study results suggest that in the future, the focus can be on fall severity advocacy and fall prevention education to attract the interest of the community elderly, and support and encouragement to their family members should also be provided, thereby improving their likelihood of taking fall prevention actions. Although *Perceived barrier* did not directly affect the likelihood of taking a fall prevention action, it can still do so via the effect

Table 5
Path analysis of structural model.

Path	SRW[a]	Standard error	*t*-value	Error Variance	*t*-value	SMC[b]
Perceived susceptibility → Self-efficacy	-0.090	0.057	-1.767	–	–	–
Perceived severity → Cue to action	0.144	0.055	3.350**	–	–	–
→ Likelihood of action	0.144	0.051	3.604**	–	–	–
Perceived benefit → Cue to action	0.508	0.062	10.480**	–	–	
→ Self-efficacy	0.290	0.050	6.545**	–	–	–
→ Likelihood of action	0.109	0.060	2.347*	–	–	–
Perceived barrier → Cue to action	-0.177	0.053	-4.298**	–	–	
→ Self-efficacy	-0.289	0.062	-5.288**	–	–	–
Cue to action → Likelihood of action	0.212	0.052	4.086**	–	–	–
Self-efficacy → Likelihood of action	0.408	0.052	8.862**	–	–	–
Cue to action	–	–	–	0.138	9.701**	0.393
Self-efficacy	–	–	–	0.307	8.566**	0.210
Likelihood of action	–	–	–	0.263	13.539**	0.390

[a] Standardized Regression Weights (SRW). [b] Squared Multiple Correlation (SMC, R^2).
* $p < 0.05$, ** $p < 0.01$.

of *Self-efficacy* and *Cue to action*. This study also showed a positive correlation between *Cue to action* and *Self-efficacy* and preventive healthy behaviors. This result is consistent with previous studies.[30,38]

The result provides evidence that the HBM is suitable for exploring the likelihood of fall prevention actions taken by community-dwelling older adults. It also identifies significant influencing factors and the influence paths between factors. The results of this study found that the elderly would take actions to prevent falls due to "watching (listening) the fall of the elderly or reminding each other" and "participate the elderly fall prevention courses organized by the community (health clinic)". Therefore, medical care professionals can apply and provide clues to prevent the elderly from falling when they provide health education and guidance. Understanding the impact process of the likelihood of fall prevention actions of the elderly in the community is important, so that a fall prevention intervention plan that is more consistent with the psychological needs of community elderly. Specifically, fall-prevention programs should be designed in the context of self-efficacy, cue to action, and perceived benefit derived from the various beliefs of older adults to improve the accessibility and applicability of related activities, and raise the effective interventions.

Conflict of interest

No.

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