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Application of Comprehensive Geriatric Assessment Combined with Tilburg Scale-Based Frailty Model in Health Evaluation of Community-Dwelling Elderly Individuals

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ABSTRACT

Objective: To apply comprehensive geriatric assessment (CGA) combined with Tilburg scale-based frailty model in the health evaluation of community-dwelling elderly individuals.

Methods: The community-dwelling elderly individuals in our city were enrolled as subjects through cluster sampling and assessed using the Tilburg frailty indicator (TFI), CGA phenotype of frailty (PF) and *Ability Assessment for Older Adults*. Then receiver operating characteristic (ROC) curves of TFI and PF alone or combination in predicting the disability status of the elderly were plotted by the nonparametric method, and corresponding area under curve (AUC) and 95% confidence interval (95% CI) were calculated. The prediction function of TFI and PF alone or combination for the disability status of the elderly was analyzed.

Results: In this study, 230 elderly individuals were surveyed, meeting the sample size estimation requirements. Among them, there were 110 males (47.8%) and 120 females (52.2%) aged 60-103 years old with (81.4 ± 8.6) years old on average. As to marital status, 47 elderly individuals (20.4%) were married, and 183 elderly individuals (79.6%) were unmarried. In terms of education level, there were 78 cases of illiteracy (33.9%), 45 cases of primary school (19.6%), 107 cases of middle school and above (46.5%). In addition, 110 of them (47.8%) suffered from two or more chronic diseases. The TFI score was 0-13-point(s), with a mean of (3.7 ± 2.7) points, and TFI ≥5 points (frailty) was found in 75 elderly individuals (32.6%, 95% CI: 28.5-37.0%). The PF score was 0-5-point(s), with an average of (2.1 ± 0.71) points, and PF ≥3 points (frailty) was detected in 74 elderly individuals (32.2%, 95% CI: 26.0-35.2%). The incidence rate of frailty screened by TFI and PF showed no statistically significant differences (χ^2=0.184, P=0.652). In the ability assessment for older adults, the activity of daily living disability, mental status disability, sensory and communication disability, social involvement disability and comprehensive disability were found in 8 (3.5%), 24 (10.4%), 26 (11.3%), 20 (8.7%) and 21 (9.1%) elderly individuals, respectively. There was a statistically significant difference in AUC of TFI and PF alone or combination in predicting the disability status of the elderly (P<0.01). AUC of TFI in predicting the activity of daily living disability, mental status disability, sensory and communication disability, social involvement disability and comprehensive disability was higher than that of PF, and AUC of TFI in combination with PF in predicting the above items was the highest. The discriminant analysis was conducted with whether there was the activity of daily living disability, mental status disability, sensory and communication disability, social involvement disability and comprehensive disability as dependent variable and TFI and PF scores as independent variables. The cross-validation accuracy of TFI in predicting the activity of daily living disability, mental status disability, sensory and communication disability, social involvement disability and comprehensive disability was higher than that of PF, and the cross-validation accuracy of TFI in combination with PF was the highest.

Conclusion: Both TFI and PF can be adopted for screening the frailty of the community-dwelling elderly individuals, but combination has higher value in predicting the disability status.

KEYWORDS: Tilburg scale; comprehensive geriatric assessment; frailty model; disability; community

INTRODUCTION

With the increase in the aging population, lengthening life expectancy is of great significance. To this end, it is essential to expand the coverage of medical services to further improve the quality of life and activity of daily living of the elderly. Frailty, one of the major risks faced by the elderly, is an age-related geriatric syndrome, which is characterized by reduced body reserves and weakened resistance and can result in such adverse outcomes as tumble, hospitalization, physical disability and death [1]. Many symptoms can be reversed if frailty is detected at an early stage and subjected to corresponding interventions by clinicians. Tilburg frailty indicator (TFI), a widely applied frailty assessment tool, has simple operations and functions well in assessing mental frailty. TFI mainly aims at the frailty of physical and psychological functions. Functional status means the ability to undertake essential or required activities in daily life, and disability is a major adverse outcome caused by physical frailty [2,3]. Comprehensive geriatric assessment (CGA) phenotype of frailty (PF) is also commonly used in health assessment [4,5]. In this study, PF and TFI were applied in the health assessment for community-dwelling elderly individuals, and the value of PF and TFI alone or in combination in predicting the disability in the health assessment for community-dwelling elderly individuals was analyzed.

MATERIALS AND METHODS

Baseline Clinical Data

The community-dwelling elderly individuals in our city were enrolled as the respondents through cluster sampling. Inclusion criteria: (1) Elderly individuals aged ≥60 years old, (2) those able to communicate, (3) those able to walk on their own with or without walking aids and complete the walk test in this study, and (4) those who were informed of this study and agreed to participate in this study of their own accord. Exclusion criteria: Elderly individuals with severe cognitive dysfunction or mental illness. With the formula for calculation of sample size of the enumeration data in status survey, where α=0.05, tα=1.96, and P = prevalence rate of a certain disease, the sample size in this study was calculated by reference to that the partially and completely disabled elderly accounted for 19% of the total elderly population reported in the *Research on Situation of Urban and Rural Disabled Elderly* in 2010. In this study, the allowable deviation (d) was 0.2P, and the calculated sample size (n) was about 210. Considering that there might be no response, the sample size was increased by 10%, and the final sample size was estimated to be about 240.

Investigation Tools

(1) The original TFI assessment scale was developed by Gobbens *et al.* [2] based on the frailty integration model, and the Chinese version of TFI scale used in this study was translated by Xi *et al.* [6] and displayed acceptable reliability and validity in patients with chronic diseases in geriatric hospitals. The scale covers 3 dimensions composed of 15 items: physical dimension (8 items: physical health, natural weight loss, dysbasia, balance, vision problems, hearing problems, grip strength and feeling of fatigue), psychological dimension (4 items: memory, depression, anxiety and coping ability) and social dimension (3 items: living alone, social relations and social support). The 0-1 scoring method is employed for each item, and the total score is 0-15 point(s). ≥5 points suggested frailty. The higher the score is, the severer the frailty will be.

(2) The CGA PF, developed by Fried *et al.* [7] on the basis of the frailty cycle model, evaluates from 5 dimensions: a. unintentional weight loss (an unexplained weight loss of ≥4.5 kg or an unexplained loss of ≥5% of weight in the past year, or an unexplained weight loss of 3 kg or more within 3 months), b. self-reported exhaustion (the answer to any one of the two was 3 days or more when the elderly were asked about how often they have felt the two items in the Chinese version of the Center for Epidemiological Studies Depression Scale (CES-D) [8]: "I felt that everything I did was a effort" and "I had trouble keeping mind on what I was doing" during the last week), c. weakness (a grip

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dynamometer was used to measure the strength of the dominant hand of the elderly, and whether there was a decline in grip strength was judged according to the judging criteria with adjusted gender and body mass index), d. drop in walking speed (the time for the elderly to walk 4.6 meters at normal speed with/without the aid of aided tools like walking sticks was measured, and whether there was a drop in walking speed was determined in accordance with the criteria set after adjusting the gender and height), and e. low physical activity level (physical activity <383 kcal for males and <270 kcal for females in investigation of the physical activity of the elderly in the last week using the Simplified Chinese version of the International Physical Activity Questionnaire - Short Form (IPAQ-SC) [9]). Non-frailty, pre-frailty and frailty are separately determined if having 0, 1-2 and ≥3 of them. 1 point is scored if having one of them, and the total score is 0-5 point(s). In this study, <3 points indicated no frailty, and ≥3 points suggested frailty.

(3) The disability status of the elderly was assessed using the professional standard *Ability Assessment for Older Adults* [10]. In this standard, the ability assessment of the elderly covers 4 dimensions (activity of daily living, mental status, sensory and communication, and social involvement) with a score of 0-100 point(s), 0-6 point(s), 0-14 point(s) and 0-20 point(s), respectively. Each dimension is classified into grade 0 (unimpaired ability), grade 1 (mild impairment), grade 2 (moderate impairment) and grade 3 (severe impairment) according to the score. Then, the grade of the above four dimensions was comprehensively evaluated, and the grade of the comprehensive ability of the elderly was obtained according to the grade change basis, including grade 0 (unimpaired ability), grade 1 (mild impairment), grade 2 (moderate impairment) and grade 3 (severe impairment). In this study, the activity of daily living, mental status, sensory and communication, social involvement and comprehensive ability of the elderly were classified into two grades (grade 0 and 1 = ability and grade 2 and 3 = disability) and analyzed.

Data Collection

The data were collected in August 2020, and pilot surveys were conducted by 10 investigators trained with uniform standards before the investigation. The general situation and the self-reported items in the two tools of elderly individuals meeting the inclusion criteria were investigated by two investigators through face-to-face interviews, and the grip strength, walking speed, height and weight of the elderly individuals were detected using unified methods and tools. The questionnaires were filled out by investigators based on the interviews and measurements. A special person was responsible for randomly checking and verifying the collected questionnaires at the survey site. There were 242 questionnaires filled out in total, and 230 of them were validated, with an effective response rate of 95.0%.

Statistical Analysis

Epidata3.1 was used to establish a database to input data, and logical verification was then carried out to ensure the data accuracy. SPSS 20.0 was utilized for statistical analysis. The receiver operating characteristic (ROC) curves of TFI and PF alone or combination in predicting the disability status of the elderly were plotted by the nonparametric method, and corresponding area under curve (AUC) and 95% confidence interval (95% CI) were calculated. The prediction function of TFI and PF alone or combination for the disability status of the elderly was analyzed.

RESULTS

Baseline Clinical Data

In this survey, 230 elderly individuals were included, meeting the sample size estimation requirements. Among them, there were 110 males (47.8%) and 120 females (52.2%) aged 60-103 years old with (81.4±8.6) years old on average. As to marital status, 47 elderly individuals (20.4%) were married, and 183 elderly individuals (79.6%) were unmarried. In terms of education level, there were 78 cases of illiteracy (33.9%), 45 cases of primary school (19.6%), 107 cases of middle school and above (46.5%). In addition, 110 of them (47.8%) suffered from two or more chronic diseases (Table 1).

Table 1. **Baseline clinical data**

Item	
Average age (years old)	81.4±8.6
Gender	
Male	110 (47.8%)
Female	120 (52.2%)
Marital status	
Married	47 (20.4%)
Unmarried	183 (79.6%)
Education level	
Illiteracy	78 (33.9%)
Primary school	45 (19.6%)
Middle school and above	107 (46.5%)
Two or more chronic diseases	110 (47.8%)

Table 2. **Frailty screening and disability status**

Item	
TFI ≥5 points	75 (32.6%)
PF ≥3 points	74 (32.2%)
Activity of daily living disability	8 (3.5%)
Mental status disability	24 (10.4%)
Sensory and communication disability	26 (11.3%)
Social involvement disability	20 (8.7%)
Comprehensive disability	21 (9.1%)

Frailty Screening and Disability Status

The TFI score was 0-13-point(s), with a mean of (3.7±2.7) points, and TFI ≥5 points (frailty) was found in 75 elderly individuals (32.6%, 95% CI: 28.5-37.0%). The PF score was 0-5-point(s), with an average of (2.1±0.71) points, and PF ≥3 points (frailty) was detected in 74 elderly individuals (32.2%, 95% CI: 26.0-35.2%). The incidence rate of frailty screened by TFI and PF showed no statistically significant differences (χ^2=0.184, P=0.652). In the ability assessment for older adults, the activity of daily living disability, mental status disability, sensory and communication disability, social involvement disability and comprehensive disability were found in 8 (3.5%), 24 (10.4%), 26 (11.3%), 20 (8.7%) and 21 (9.1%) elderly individuals, respectively (Table 2).

ROC Curve Results of TFI And Pf Alone or Combination in Predicting Disability Status

There was a statistically significant difference in AUC of TFI and PF alone or combination in predicting the disability status of the elderly (P<0.01). AUC of TFI in predicting the activity of daily living disability, mental status disability, sensory and communication disability, social involvement disability and comprehensive disability was higher than that of PF, and AUC of TFI in combination with PF in predicting the above dimensions was the highest (Table 3).

Table 3. **ROC curve results of TFI and PF alone or combination in predicting disability status**

	Sensitivity	Specificity	Youden index	AUC (95% CI)	P
Activity of daily living disability	0.784	0.803	0.591	0.829 (0.709, 0.950)	0.002
TFI	0.713	0.711	0.412	0.783 (0.657, 0.896)	0.003
PF	0.803	0.829	0.604	0.856 (0.725, 0.964)	0.000
TFI + PF					
Mental status disability	0.748	0.642	0.388	0.739 (0.684, 0.784)	0.000
TFI	0.502	0.728	0.234	0.653 (0.509, 0.792)	0.000
PF	0.783	0.754	0.421	0.812 (0.711, 0.856)	0.000
TFI + PF					
Sensory and communication disability	0.823	0.442	0.482	0.693 (0.619, 0.7640)	0.002
TFI	0.845	0.312	0.254	0.613 (0.589, 0.703)	0.000
PF	0.886	0.543	0.506	0.729 (0.659, 0.850)	0.000
TFI + PF					
Social involvement disability	0.763	0.711	0.487	0.812 (0.745, 0.911)	0.003
TFI	0.921	0.303	0.257	0.659 (0.545, 0.836)	0.000
PF	0.945	0.814	0.923	0.843 (0.779, 0.926)	0.000
TFI + PF					
Comprehensive disability	0.734	0.729	0.774	0.774 (0.692, 0.865)	0.004
TFI	0.511	0.714	0.693	0.669 (0.613, 0.892)	0.000
PF	0.824	0.757	0.803	0.846 (0.713, 0.965)	0.000
TFI + PF	0.784	0.803	0.591	0.829 (0.709, 0.950)	0.002

Bayes Discriminant Analysis Results of TFI and PF Alone or Combination in Predicting Disability Status

The discriminant analysis was conducted with whether there was activity of daily living disability, mental status disability, sensory and communication disability, social involvement disability and comprehensive disability as the dependent variable and TFI and PF scores as the independent variables. The discriminant function is shown in Table 4. It was uncovered that the cross-validation accuracy of TFI in predicting the activity of daily living disability, mental status disability, sensory and communication disability, social involvement disability and comprehensive disability was higher than that of PF, and the cross-validation accuracy of TFI in combination with PF was the highest.

Table 4. **Bayes discriminant analysis results of TFI and PF alone or combination in predicting disability status**

	Discriminant function	Cross-validation accuracy (%)
Activity of daily living disability		
TFI	Y=1.718X-5.230	82.5
PF	Y=2.326X-5.123	71.3
TFI + PF	Y=3.126X-5.029	84.5
Mental status disability		
TFI	Y=0.884X-3.127	60.5
PF	Y=2.182X-3.214	51.0
TFI + PF	Y=2.463X-2.983	68.5
Sensory and communication disability		
TFI	Y=0.803X-2.354	51.0
PF	Y=2.108X-2.184	44.0
TFI + PF	Y=2.984X-2.036	56.0
Social involvement disability		
TFI	Y=1.032X-3.243	67.5
PF	Y=2.039X-4.392	49.0
TFI + PF	Y=3.284X-5.093	71.5
Comprehensive disability		
TFI	Y=1.092X-4.398	75.0
PF	Y=1.564X-4.028	52.0
TFI + PF	Y=2.164X-5.116	78.5

DISCUSSION

In this study, the incidence rate of frailty in elderly in nursing institutions for the aged screened by TFI and PF was 32.6% and 32.2%, respectively, with no statistically significant difference between them. This implies that TFI and PF are comparable in screening the detection rate of frailty of the elderly in nursing institutions for the aged. The high detection rate of frailty in the elderly in this study may be because the respondents in this study were community-dwelling elderly individuals who had poor ability and health status.

Besides, ROC curves and Bayes discriminant analysis were adopted to analyze the ability of TFI and PF alone and TFI in combination with PF to predict the disability of the elderly individuals. The ROC curve is an effective method for evaluating the pros and cons of the authenticity of two or more test methods for the same disease. The Bayes discriminant analysis has a more statistically supported theoretical basis than typical Fisher's discriminant analysis. In this study, the results of ROC analysis showed that AUC of TFI and PF was 0.692-0.865 and 0.613-0.892, respectively, implying that both TFI and PF are accurate to some extent in predicting the disability status of the elderly. Besides, the accuracy of the above two assessment tools was the highest in predicting the activity of daily living disability, which may be because more cases of physical frailty are screened by them. In addition, AUC of TFI + PF was the highest. AUC of TFI in predicting the activity of daily living disability, mental status disability, sensory and communication disability, social involvement disability and comprehensive disability was higher than that of PF, and AUC of TFI in combination with PF in predicting the above five dimensions was the highest, suggesting that TFI in combination with PF has the best prediction function to the disability status of the elderly in nursing institutions for the aged. Moreover, it was uncovered in discriminant analysis that the cross-validation accuracy of TFI in predicting the activity of daily living disability, mental status disability, sensory and communication disability, social involvement disability and comprehensive disability was higher than that of PF, and the cross-validation accuracy of TFI in combination with PF was the highest, further indicating that TFI in combination with PF has the best prediction function to the disability status of the elderly. With the frailty integration model as the theoretical basis, TFI assesses the disability status of the elderly from physical, psychological and social dimensions and more comprehensively reflects the overall health status of the elderly. Therefore, it was superior to PF in predicting the overall functional status of the elderly. This result is consistent with the results of the study conducted by Coelho *et al.* [11], in which the application effects of the two tools were compared with the quality of life as the outcome indicator. The conclusion of this study enriches the prediction function of frailty assessment tools to outcome indicators and indicates that the prediction function of different

assessment tools shall be taken into account when predicting different health outcomes of the elderly.

This study provides a reference for the application of TFI and PF in screening the frailty and predicting the disability status of community-dwelling elderly individuals. However, in the future, whether other frailty assessment tools including frailty index [12], Groningen frailty indicator [13] and clinical frailty scale [14] are more suitable for screening the frailty of the elderly in nursing institutions for the aged, and whether specific tools for screening the frailty of the elderly in nursing institutions for the aged can be developed need further exploration.

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