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Factors Associated with Frailty: A Population Based-study among the Rural Elderly Community Dwellers

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ABSTRACT

***Purpose**: The aims of this study were (1) to identify factors associated with frailty and (2) to determine the ability of the identified factors to predict frailty among the rural elderly community-dwellers.* ***Method**: One hundred randomly selected elderly community dwellers, who were 65 to 80 years old, completed the Mini-Mental State Examination (MMSE), Geriatric Depression Scale (GDS), Physical Performance Test (PPT) and questionnaires.* ***Results**: Logistic regression models showed that cognitive function, as measured by the Mini-Mental State Examination, had the strongest association with frailty; education, age, and Geriatric Depression Scale were also significant indicators of low risk of frailty.* ***Conclusion**: The interrelated nature of cognitive function and functional status found in the present study highlights the importance of cognitive impairment on frailty; since cognitive function had the strongest association with physical frailty to an extent greater than any of the other variables measured, adding a treatment regimen that stimulates cognitive function may further enhance functional level or prevent decline of functional status compared with prescribing exercise intervention alone.*

Key words: frailty, cognitive function, functional status, elderly

INTRODUCTION

Frailty associated with aging has been well described by a number of investigators (Bortz 2002; Schuurmans et al., 2004). Although there is no explicit definition for physical frailty, it is commonly accepted that frail elderly have difficulty with fundamental tasks such as dressing, shopping, household work, and ambulation (Rockwood et al., 1994; Brown et al., 1995). The importance of locomotion in the value systems of elderly people emphasizes the high profile of physiotherapist in the care of elderly people (Partridge et al., 1996).

Evidences indicate that rural individuals have limited access to health care and that rural areas are underserved with medical professionals. Many rural individuals must travel substantial distance for primary medical care, requires significant longer travel times to reach care than their urban counterparts. Because rural populations are underserved and have difficulties in accessing care, their health status is particularly important. In Poland, infectious diseases (other than tuberculosis), frailty at birth and frailty in old age were the most frequent cause of death in rural areas (Budnik and Liczbinska 2006). In late1970s, World Health Organization promotes the concept of Community-based rehabilitation (CBR). CBR is a common form of service delivery that focus on providing effective rehabilitation activities for children and adults with disabilities in underserved areas (Wirz and Thomas 2002). In June 2003, during the 15th General Meeting of the World Confederation for Physical Therapy (WCPT), the WCPT council declares their support in the development of CBR and recognizes the important contribution of physical therapists in CBR (World Health Organization 2003). However, despite the incremental progress made in CBR in the past 25 years, CBR has not yet developed sufficient published literature about planning, implementation and evaluation of effective service delivery. A population-based study concerning frailty of the underserved community will be a useful guide for efficient service delivery.

The aims of this study were (1) to identify factors associated with frailty and (2) to determine the ability of the identified factors to predict frailty among the rural community-dwelling elderly people. We hypothesized that three domains would influence frailty among the rural elderly community dwellers: a) demographic factors, b) number of chronic diseases, and c) psychosocial factors. Knowing the factors that are associated with frailty provide not only secondary and tertiary prevention but may also be used in the future development of physical therapy treatment regimens.

METHODS

Sample

A cross-sectional study design was used among 65-80 year old community-dwelling elderly people residing in two rural communities (North and South Manuwangan, Cotabato Province) in Southern Mindanao, Philippines. Manuwangan is an agricultural rural area. Lists of potential subjects were obtained from the local administrative offices. All persons aged 65-80 years old at the time of data collection who were registered at the administrative offices were included in the random sampling. From a total list of 326 community-dwelling elderly people, a sample of 100 individuals (50 in each study site) was selected by draw lots (pieces of paper with names written on them were drawn from a box).

After the subjects were selected, two social workers from the respective communities were requested to contact the selected subjects and inform them about the

purpose and research protocol of the study. The social workers were also instructed to ask for the participants' consent to participate in the study, which was approved by the Human Studies Committee of the International University of Health and Welfare. If, however, subjects had had a severe stroke, had congestive heart failure, were in a coma, had severe psychiatric disorders, abused alcohol or drugs, were experiencing acute stages of a terminal illness, used assistive devices other than canes and crutches, or refused to participate in the research, the social workers were asked to report this to the researchers so that a new subject could be drawn from the list.

Dependent Variable

Functional status was measured using the 7-item Physical Performance Test (PPT). The 7-item and 9-item PPT measures, developed by Reuben and Siu in 1990, are commonly used to test the overall functional ability of elderly people (Lusardi, Pellecchia et al., 2003). The 7-item PPT includes writing a sentence, simulating eating, lifting a book and placing it on a shelf, donning and removing a jacket, picking up a penny from the floor, turning 360 degrees while standing, and walking 50 feet (Reuben and Siu 1990). The total score ranges from 0 (worst performance) to 28 (best performance). The PPT was administered using a standardized set of tools.

The PPT was used as a measure of frailty. Based on PPT scores recommended by Lusardi et al., (2003), subjects were divided into two groups. The group with PPT scores ranging from 20 to 28 was considered "not frail", whereas the group with PPT scores $\leq$19 was considered to be "frail".

Independent Variables

Psychosocial Factors

The cognitive test used in this research was the Mini-Mental State Examination (MMSE). The MMSE includes 11 items that assess abilities of orientation (time and place), registration, attention, recall, naming, repetition, command, reading, writing and copying (Folstein, Folstein et al., 1975).

Symptoms of depression were assessed using the Geriatric Depression Scale (GDS), a 30-item scale that has been shown to be useful in distinguishing elderly depressed subjects from non-depressed subjects. According to Yesavage et al. (1982), a score of 0-10 should be considered normal, whereas a score of $\geq$11 is indicative of depression. On the other hand, Burke et al. (1992) recommend a cut-off point of $\geq$14 for possible depression.

Demographic variables

The subjects were asked directly concerning their gender, age, employment status, and educational attainment.

Number of chronic diseases

The number of chronic diseases suffered by the subjects was assessed using the following question: "Has your doctor ever told you that you suffer from ... (disease)?": heart disease, anemia, diabetes mellitus, liver disease, previous stroke, chronic bronchitis or asthma, poor hearing, cancer, cataracts, motor problems of the extremities, hypertension, Chronic Obstructive Pulmonary Disease (COPD), previous bone fracture, Parkinson's disease, degenerative joint disease or osteoarthritis, hip fracture, poor vision, obesity, and prostate disease.

Procedures

Having previously described in detail the research protocol and the evaluation technique to the bilingual raters (two physical therapists and a nurse), the first author held two meetings with the raters prior to the interviews. First, a 2-hour session focused on demonstrating and practicing the measurement methods and answering any of their questions. Second, raters were asked to administer and score the PPT, GDS, and MMSE to ten community-dwelling elderly people who were not part of the study sample. After administering the tests, the raters' doubts and difficulties were addressed.

Selected and eligible subjects who agreed to participate were interviewed at home in their preferred language (English or the local language) by the raters.

Data Analysis

All statistical analyses were performed using the SPSS (Statistical Package for the Social Sciences) software, version 12. Descriptive statistics were calculated to determine the mean and distribution of values for each of the variables. In correlation analysis, Pearson's correlation coefficient was used between continuous variables, Eta was used between continuous and discrete variables, while Cramer's V was used for both nominally measured variables. Logistic regression analyses, as the primary statistical analysis, were applied using the Wald statistical technique to test the objectives of this study. The enter method was used and the stepwise probability was set at 0.05 for entry and 0.10 for removal. The goodness of fit of the model was tested using the log likelihood, Chi-square, or Omnibus test.

RESULTS

Descriptive and Inferential Characteristics

Table 1 shows descriptive statistics for the independent variables and functional status. Study subjects were individuals aged 65 to 80 years old (mean=69.9; SD=4.4) and were predominantly female (63%). A large proportion of the subjects had 6 to 10 years of formal education (55%), and only 29% of the entire samples were employed. Only 6% (6 subjects) declared that they were free of any chronic conditions, while 67% suffered from two or more conditions. The most prevalent disorders were visual impairment (60%), hypertension (44%), and heart disease (30%). The average MMSE score was

24.1 (SD = 4.5), which lies in the range of "no cognitive impairment". More than half of the subjects (63%) scored in the "no cognitive impairment" range (24-30); 27% scored in the "mild cognitive impairment" range (18-23); and 10% scored in the "severe cognitive impairment" range (0-17). Thus, 37% of the subjects had some degree of cognitive impairment. The mean score for GDS was 17.5 (SD=3.3). Using the recommended cut-off score of Burke et al. (1992), 90% of the subjects were possibly suffering from depression, whereas 10% were not. On the other hand, grouping subjects based on the cut-off score of Yesage et al. (1982), 97% of the subjects were likely to be suffering from depression, whereas 3% were not. In summary, more than 90% of the subjects could be classified as being depressed. The PPT mean score of this population was 18.7 (SD=4.0). The mean score in this study sample was lower than the population studied by Brach et al. (2002) and Lusardi et al. (2003).

Table 2 shows the correlation analyses between independent variables and PPT that have been used in constructing the regression models. In these analyses, age ($r = -0.23$; $p<0.05$), education ($r = 0.28$; $p<0.01$), MMSE ($r=0.61$; $p<0.001$), and GDS ($r = -0.22$; $p<0.05$) were significantly correlated with PPT, whereas gender ($r = 0.16$; $p=0.11$), chronic diseases ($r=-0.08$; $p=0.43$) and employment status ($r = 0.17$; $p=0.09$) were not.

Logistic Regression Analysis

The general form of the regression model is as follows:

$$z = \beta_0 + \beta_1 x_1 + \beta_2 x_2 \ldots + \beta_n x_n$$

Where z = the linear combination, β_0 = constant, $\beta_1, \beta_2 \ldots \beta_n$ = partial regression coefficients, and $x_1, x_2 \ldots x_n$ are independent variables

Only variables that were significantly correlated with PPT were entered into the logistic regression models with functional status (0 = Non-frail elder; 1 = Frail elder) as the dependent variable. The regression model was assessed for goodness of fit; 78% of all cases were found to be correctly classified according to functional level. The Chi-square value was 42.265 ($p < 0.001$), indicating that the likelihood of obtaining the result by chance, that is, the probability that the model did not actually fit the data, is less than 1 in 10,000 (data not shown). For each regression analysis, the variables were entered into the regression equation in the following categories: age as a continuous variable; education (0 = at most high school level; 1 = at least college level); level of cognitive function as measured by MMSE (continuous); and level of depression using GDS (continuous).

We analyzed the individual contribution of the significant independent variables using simple logistic regression analyses. In these models, education and MMSE were inversely correlated with frailty, whereas age and GDS were directly correlated with frailty (Table 3). In the multiple logistic regression model, only MMSE found to have a significant association with frailty. Age, education, and GDS did not contribute any significant variance (Table 4). The Nagelkerke R squared showed that MMSE explained

42% of the variance of frailty (Table 3). Adding age, education and GDS, the Nagelkerke R squared had increased only to 46% (Table 4).

Given the regression coefficients in Table 4, the logistic equation for the probability that an elderly person will become frail, denoted by PF, is : Probability of PF = $1/1 + e^{-z}$, where e is the base of the natural logarithm, and z = 7.42 + 0.04 (Age) - 6.98 (Education) – 0.36 (MMSE) + 0.05 (GDS).

Applying this model to an elderly person who is 80 years old with low educational attainment (0), low cognitive function (MMSE = 10) and high GDS (28), the regression model is: z = 7.42 + 0.04(80) – 6.98 (0) – 0.36(10) + 0.05(28) = 8.42. The probability of frailty is then estimated to be: Probability of PF = $1/1 + e^{-(8.42)}$ = 0.9998 or 99.98%. On the other hand, the risk of becoming frail of an elderly person can be reduced by increasing the cognitive function and lowering the GDS. The probability of an elderly person to become frail if the MMSE is high (e.g. 28) and the GDS is low (e.g.10), while age is 80 is equal to 89.28 % – a reduction of 10.70 %.

DISCUSSION

The analyses in this study showed that in a representative sample of rural community-dwelling elderly men and women 65-80 years old, education and MMSE were inversely correlated with frailty, whereas age and GDS were directly correlated with frailty and that they are able to predict frailty with 99.98% accuracy. Furthermore, our study showed that cognitive function had the strongest association with frailty to an extent greater than that of the other significant variables.

Socioeconomic conditions have been shown to influence health status (Alwin and Wray 2005; Andresen and Miller 2005). There is general agreement that employment status, education, and income may be used as socioeconomic indicators (White 1982). Employment status is a conventional measure of position in the socioeconomic hierarchy, and it is more closely connected with working conditions than other socioeconomic indicators (Gregorio, Walsh et al., 1997). In our study, the employment status was not correlated with frailty. The probable explanation for this finding is that only 24% of our subjects were employed, and even in cases in which subjects were employed, the majority was employed part-time. On the other hand, education was inversely correlated with frailty, which implies that the lower the educational attainment of the elderly person, the higher is the probability of frailty. In health behavior research, educational attainment is an important socioeconomic indicator, as it may reflect skills and knowledge that are important for making health behavior choices (for example, regarding exercise and smoking) (Mirowsky and Ross 1998; Backlund, Sorlie et al., 1999;). MMSE was also found to be inversely associated with frailty, such that those subjects with higher levels of cognitive function had lower

probability of frailty. In the longitudinal study of the Kungsholmen Project, Aguero–Torres et al. (1998) concludes that "low MMSE performance was the major determinant of development of dependence and decline of functional status over 3 years"(p.1454).

Age showed a clear direct association with frailty, which suggests that the older the person, the higher is the probability of becoming frail. This finding is similar to that found in previous research studies (Binder, Storandt et al., 1999; Lusardi, Pellecchia et al., 2003). GDS was also directly related to frailty, that is, subjects with higher levels of depression had higher probabilities of becoming frail. Clinical data on depressed patients indicate that major depression increases the risk of mortality and impaired psychosocial functioning (Mintz J, Mintz et al., 1992; Coryell, Scheftner et al., 1993). In the Established Populations for Epidemiologic Studies of Elderly, Penninx et al. (1999) found that "persistent somatic symptoms of depression such as fatigue and pain may affect physical disability levels over time"(p.1352).

We extended our study by analyzing the simultaneous effect of significant independent variables on frailty using the multiple logistic regression model. When the combined effects of significant variables were examined, educational attainment, age, and level of depression did not account for significant unique variance; only cognitive function was found to significantly affect frailty. Our findings are consistent with previous reports (Chen, Yu et al., 1995; Aguero-Torres, Fratiglioni et al., 1998). Longitudinal- and cross-sectional studies have consistently reported that dementia, as measured by MMSE, is a powerful indictor of functional disability in the elderly in studies of demented and nondemented subjects (Mulrow, Gerety et al., 1994; Aguero-Torres, Fratiglioni et al., 1998). Comijs et al (2005) observed that people with cognitive decline were still able to perform daily activities, but had some problems due to the slowing of motor activities (p. 321). Although cognitively impaired individuals may be able to accomplish a given task, their efficiency in performing the task appears to be diminished.

In conclusion, cognitive function had the strongest association with frailty. Although the level of depression, age and education appears to have a very weak systematic effect on frailty among community dwellers in the populations studied, this finding does not rule out education, age and level of depression affect specific aspects of physical function.

Certain limitations to the present study should be noted. First, the 7-item PPT test assesses functional status by measuring the time required to perform a task and uses a predetermined scoring rule (Reuben and Siu 1990). Since subjects in our study might have moved more quickly than their usual pace, the tests may not have accurately captured their true functional ability. However, using self-reported functional measurements cannot assess preclinical disability, which is common among elderly people (Rozzini, Frisoni et al., 1993; Brach, Van Swearingen 2002). Second, we used

self-reported disease, which has the disadvantage of being misdiagnosed and misreported. However, agreement of self-reported diseases and medical records has been shown elsewhere (Krueger 1957; Haapanen, Miilunpalo et al,. 1997). Finally, this study did not include mass index, social integration, and environmental factors, which can directly or indirectly affect frailty. In this study, we were able to observe approximately 46% of the variance in frailty. Incorporating mass index, social integration, and environmental factors might explain the other 54% of the variance.

CONCLUSION

In this study of randomly selected rural elderly community dwellers, cognitive function had the strongest association with frailty relative to other related variables. Knowing the factors that are associated with frailty allows not only the deployment of secondary and tertiary prevention resources, but also suggests an effective treatment regimen for rehabilitation.

The standard treatment for frailty in clinical rehabilitation is physical exercise (Hage, Mattsson et al., 2003; Rydeskog, Frandin et al., 2005). The interrelated nature of cognitive function and functional status found in the present study highlights the importance of cognitive impairment on frailty. According to Berendsen et al (2002), "although motor intelligence seems important in rehabilitation, concepts or theories of motor learning and related issues, are very rarely taken into account by physical therapist in clinical settings"(p.102)

In our study, since cognitive function had the strongest association with physical frailty to an extent greater than any of the other variables measured, adding a treatment regimen that stimulates cognitive function may further enhance functional level or prevent decline of functional status compared with prescribing exercise intervention alone. An experimental research to test this hypothesis would provide evidence of whether increasing level of cognitive function can affect risk of frailty among the elderly.

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