ABSTRACT. Besides functional impairment, several factors have been associated with mortality in institutionalized older subjects, including advanced age, gender, comorbidity, and malnutrition. We investigated the possible association of a large number of factors, including functional, anthropometric, nutritional, metabolic, clinical, and demographic variables, with two-year all-cause mortality in a sample of 344 institutionalized older subjects (≥65 years) without evidence of acute illness at the time of observation. Although a number of factors were associated with mortality risk, multivariate analysis showed that only severe disability (6 vs 0-1 lost ADL, O.R.: 3.37, C.I. 95%: 1.76-7.3) and low albumin levels (lowest vs highest tertile: O.R.: 3.0, C.I. 95%: 1.65-5.43) were independent predictors of outcome. Moreover, in the analysis stratified for degree of disability and albumin tertiles, we found a strong gradient in mortality risk with increasing disability and decreasing albumin levels. These results further support the value of these two simple parameters in identifying frail institutionalized older individuals.

INTRODUCTION

In the last few decades, the number of elderly subjects living in institutions has grown significantly in Western countries. Nursing home residents are affected by multiple chronic medical conditions, and variable degrees of functional impairment. An awareness of the possible predictors of mortality is necessary for a correct prescription of drugs, utilization of procedures and tests, and definition of the care goals as well as the prognosis. Furthermore, the identification of potentially reversible predictors of death should allow specific treatment of the high risk subjects. Besides disability in activities of daily living (ADL) (1, 2), several other factors have been associated with mortality in older individuals including malnutrition (3), involuntary weight loss (4), low cholesterol (5), albumin levels (2), advanced age (2-3), and comorbidity (6, 7).

Although many mortality-related factors have been reported, only a few studies have considered their simultaneous effect on mortality in established nursing home residents (8). This is an important issue as different factors may often coexist in the single individual. Increasing age and comorbidity have been associated with disability (9); furthermore, severe disability is associated with anthropometric and biohumoral modifications suggesting the presence of malnutrition (10).

In the present study we investigated the possible association of a large number of parameters, including functional, anthropometric, nutritional, metabolic, clinical, and demographic variables, with two-year total mortality in a sample of established older nursing home residents.

SUBJECTS AND METHODS

Study population

The Istituto di Riposo per Anziani (IRA) study is a longitudinal study designed to evaluate the relationship

Key words: Albumin, disability, frail elderly, mortality, nursing home.

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between a large number of biological parameters, and future disability and mortality, in a sample of older nursing home residents (10).

Three hundred and forty-four subjects (272 females and 72 males) were recruited in 1990 from the 410 residents of the IRA nursing home (Padova, Italy). Inclusion criteria were: 1) age ≥65 years; 2) residence in the nursing home for at least two months; and 3) no clinical evidence of acute illness at the time of observation, nor in the previous 30 days. Terminal patients with cancer or severe liver and kidney disease were excluded.

**Anthropometric parameters**

Weight, height, tricipital and subcapular skinfold thickness, and waist and hip circumference were measured by the same physician according to standardized methods (11). The Body Mass Index (BMI: kg/m²) and the waist/hip ratio (WHR) were calculated. A Holtain caliper was used to quantify skinfold thickness. Body water, resistance, and reactance were determined by tetrapolar bioelectric impedance analysis (12, 13), using a BIA 109 instrument (RJL System, Detroit, USA).

**Clinical chemistry parameters**

All determinations were performed in the central laboratory of the Geriatric Hospital of Padova, which complies with a quality control program. Blood samples were obtained in the morning after a 12-hour overnight fast, kept at 4°C for 1 hour, and then centrifuged at 3000 rpm for 10 minutes at 4°C to obtain serum or plasma. Serum total protein and iron were measured by spectrophotometry, while albumin and transferrin were assayed by nephelometry. Blood cell counts were evaluated using a Bayer-H600 instrument. Total cholesterol (TC) and triglycerides (TG) were assayed by the Trinder method. HDL-cholesterol (HDL-C) was determined after precipitation of apo B-containing lipoproteins with MgCl₂-phosphotungstic acid, while apo A-I and B were measured by nephelometry. LDL-C was calculated by the Friedewald formula (14). Plasma glucose and uric acid were measured by spectrophotometry. TSH, T3, and T4 were determined by the R.I.A. method.

**Health and functional status**

Age, gender, number of chronic medical conditions, and currently used drugs were recorded at baseline. ADL were evaluated by the geriatricians working in the nursing home, and the subjects were classified by the Katz index (15) according to their progressive dependence in feeding, continence, moving about, going to toilette, dressing, and bathing. Subjects were divided into three groups: I (0-1 lost ADL), II (2-5 lost ADL), and III (6 lost ADL). The subjects who had lost 2-3 and 4-5 ADL showed a very similar 2-year mortality probability (33.4% and 32.9%, respectively), and were collected in group II. Chronic medical conditions were ascertained by the geriatrician working in the nursing home using multiple sources of information, including the participant’s interview, physical examination, current medication list, blood test results, and medical records. Disease categories used in this analysis were: heart disease, including coronary heart disease and congestive heart failure (39%); dementia (30%); stroke (27%); parkinsonism (21%); hypertension (20%); depression (15%); diabetes mellitus (10%); and chronic obstructive pulmonary disease (6%). Comorbidity level was defined as the total number of conditions, and subjects were categorized into three groups: I (≤2), II (3-5), and III (>5 chronic diseases).

**Statistical analysis**

Mean values were compared by unpaired Student’s t-test, prevalences by the İ2 test.

Two-year survival function was estimated by the Kaplan-Meier method; the Wilcoxon test and Long Rank test were used to test differences between curves.

Forward stepwise multivariate logistic regression analyses were used to identify the variables associated with mortality (p for entry and removal was 0.05 and 0.10, respectively). The independent variables were first organized into three “homogeneous” groups that were considered separately in different logistic models: 1) anthropometric parameters (BMI, subcapular and tricipital skinfold thickness, WHR, body water, resistance, reactance, % fat free-mass, and % fat); 2) nutritional parameters (albumin, transferrin, total protein, serum iron, hemoglobin, red and white blood cell count, hematocrit, Na, K, Cl, vitamin B-12, and folic acid); and 3) metabolic parameters (total, LDL, and HDL-cholesterol, triglycerides, apo A-I, apo B, blood glucose, HbA₁c, T3, T4, TSH, and blood urea). Successively, the previously selected variables were included in the final model.

**RESULTS**

Two-year mortality increased progressively with increasing age (75-84 vs 65-74 years: O.R.: 2.0, C.I. 95%: 0.95-4.23; ≥85 vs 65-74 years: O.R.: 2.7, C.I. 95%: 1.31-5.91). The mortality rate was higher in males vs females (M: 44.5% vs F: 35%), and a significant gender difference emerged (O.R.: 1.74, C.I. 95%: 1.006-3.01) after adjustment for age.