The Relationship Between Nutritional Status and Physical Function, Admission Frequency, Length of Hospital Stay, and Mortality in Old People Living in Long-Term Care Facilities

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ABSTRACT

Background: Nutrition is an important issue for elderly residents of long-term care facilities (LTCFs). About 20% of elderly LTCF residents in Taiwan are malnourished.

Purpose: This study investigated correlations between nutritional status and physical function, admission frequency, hospital stay duration, and mortality in elderly LTCF residents.

Methods: Researchers used a retrospective study design and convenient sampling to enroll 174 subjects aged 67 to 105 years (average, 82.5 years) who were living in legally registered LTCFs in Beitou District, Taipei City, Taiwan. A review of LTCF resident files provided data on subjects' demographics, physical examination laboratory results for the most recent 1-year period, anthropometry, physical function, admission frequency, hospital stay duration, and causes of admissions. Subjects had lived in their LTCF for more than 1 year before their enrollment date. Subjects who died during and after the study period were also included in analysis.

Results: Results showed significant changes over the study year in subjects' nutritional status, physical function, and calf circumference. Physical function was found significantly correlated with calf circumference, hospitalization status was found correlated with nasal-gastric tube feeding status, and eating pattern was found correlated with calf circumference and levels of both serum albumin and cholesterol. Nutritional status, calf circumference, albumin level, and cholesterol level also correlated significantly with hospitalization status. In this study, the likelihood of hospitalization increased with age and nasal-gastric tube feeding use. Hospital stay duration for subjects receiving nasal-gastric tube feeding was longer than that for those receiving oral feeding. Also, weak nutritional status scores for calf circumference and hemoglobin levels were factors associated with increased mortality risk.

Conclusions/Implications for Practice: Findings recommend that greater attention should be paid to the nutritional status of elderly persons living in LTCFs to reduce hospitalization and death risks, cut medical expenses, and improve quality of care.

Key Words: long-term care facility, nutritional status, admission frequency, hospital stay duration, mortality.

Introduction

Taiwan's aging population has made care of old people a critical issue. Demand for long-term care facilities (LTCFs) for old people has increased. According to Taiwan's Department of Social Affairs under the Ministry of the Interior (2011), there were only 183 public and private LTCFs in Taiwan at the end of 1999. At the end of January 2011, this number had increased to 1,050, indicating strong demand.

Elderly health is complex, and changes in nutritional status are critical. The physical, mental, and social deterioration that accompanies aging directly or indirectly restricts diet quantity and quality, which can result in dystrophy or malnutrition (Singh, Bhaldratie, Bondin, & Goorah, 2010). Russell and Elia (2008) highlighted the risk of malnutrition growing with age and noted a higher incidence among those currently receiving care or living in institutions. Studies addressing the situation in various countries found that some 35%–65% of hospitalized old people (Omran & Morley, 2000; Stechmiller, 2003; Suominen, Sandelin, Soini, & Pitkala, 2009) and 20%–50% of elderly LTCF residents experienced malnutrition (Chen, 2007; Chiu, Lin, Hsieh, 2012).
Li, & Chiou, 2005; Visvanathan, Penhall, & Chapman, 2004). Guigoz, Lauque, and Vellas (2002) assessed the nutritional status of 2,264 elderly residents of 12 LTCFs in Switzerland and found that 37% experienced malnutrition and 44% experienced potential nutritional risk.

Deterioration in physical function is common in old people. Physical function disability refers to the inability to execute self-care and participate in community activities such as those included under activities of daily living (ADLs), instrumented ADLs, and mobility and balance (Verbrugge & Jette, 1994). Physical function disability is not only a predictive factor of health status, eligibility for nursing home admission (Ostir, Markides, Black, & Goodwin, 1998), and mortality in old people but also menaces their physical and psychological health (Cress et al., 1995). Taiwan’s Department of Statistics identified 9.11% of Taiwan’s old people as having one or more disabilities in 2009 (Taiwan Association of Long-Term Care Professionals, 2003) and old people with disabilities accounting for the largest population receiving long-term care. Shyu, Hsiung, Dai, Chen, and Huang (1993) found in a survey of 143 residents living in 37 elderly care facilities that 36.4% were completely dependent and required nutritional intake assistance.

Previous studies have suggested a close association between nutritional status during hospitalization and longer hospital stays, patient mortality before and after discharge, and other complications (Atalay, Yagmur, Nursal, Atalay, & Noyam, 2008; Kaur, Miller, Halbert, Giles, & Crotty, 2008; Volkert, Pauly, Stehle, & Sieber, 2011). In Taiwan, Chan (2000) used the Mini Nutritional Assessment to investigate conscious elderly living in communities and care facilities. They identified a medical service utilization effect on nutritional status and found that old people with poorer nutrition used outpatient clinics, emergency rooms, and admission services more frequently. Failure to prevent or treat malnutrition early on can further restrict patient motility and cause decreased immunity, increased infection risk, pressure sores, delayed wound healing, poor prognoses, and depression. Also, patient mental health and quality of life may be affected (Keller, Ostbye, & Goy, 2004; Kvamme, Gronil, Florholmen, & Jacobsen, 2011), and risks of morbidity, infection, complication, and death may increase (Keller & Ostbye, 2003; Volkert et al., 2011). The purpose of this study was to investigate the nutritional status of old people living in LTCFs and analyze nutrition-related predictors affecting physical function, admission frequency, hospital stay duration, and mortality.

**Methods**

**Research Design**

This study used a retrospective design and collected demographic, physical examination (serum albumin, hemoglobin, and cholesterol), anthropometry (body mass index [BMI] and calf circumference), physical function (Barthel index), admission frequency, hospital stay duration, and cause of death data from subjects’ medical records.

**Study Sites and Subjects**

This study used convenience sampling. Subjects were all residents of legally registered LTCFs located in Taipei City’s Beitou District in Taiwan. Subjects’ inclusion criteria included (a) aged 65 years or older and (b) enrolled as an LTCF resident for more than a year (including those who had passed away within that period). The eight LTCFs targeted for data collection were selected because of their long-term cooperation with the researchers. Residents of those eight facilities had all completed their health examinations and laboratory tests at the same medical center. Also, all participating LTCFs used the same brand of chair scale to measure body weight.

**Data Collection**

This study used a retrospective design. Data were collected from subjects’ medical records.

**Demographic data**

Researchers collected demographic data in two areas:

- Personal characteristics: Gender, age, feeding pattern, number of diagnosed chronic diseases, type of chronic diseases, number of medications used, and type of medications used.
- Physical function, hospitalization, and survival status:
  - Barthel index score (physical function), admission frequency, hospital stay duration, and survival status/cause of death.

The Barthel index is used worldwide to assess functional independence and mobility. It is an ordinal scale that compares 10 ADLs scored on a 5-point gradient scale with a maximum total score of 100. Barthel index scale reliability is quite high, earning a Cronbach’s alpha of .90. Validity analysis of the convergent criterion using the Functional Independence Measure showed satisfactory correlation in most areas. Explained variance was 63.8% in a factor analysis that retained 1 domain and 10 original scale items (Minosso, Amendola, Alvarenga, & Oliveira, 2010).

**Nutritional status**

This data sheet included two parts:

- Physical examination laboratory tests: Serum albumin, hemoglobin, and cholesterol.
- Anthropometry: BMI and calf circumference.

BMI was calculated as body weight in kilograms divided by squared height in meters. Height was measured to the nearest 0.1 cm using a stadiometer. When no valid height measurement could be obtained because of reasons such as inability to stand, researchers measured the knee height of the left leg using a Mediform sliding caliper with...
knee and ankle joints fixed at 90° angles (Wijnhoven et al., 2010). Weight was measured to the nearest 0.1 kg using a chair scale (BW-130; ISO 9001 and ISO13485 approved and CE accredited).

Researchers measured calf circumference at the point of widest circumference to the nearest 0.1 cm on the left leg (right leg for left-handed persons). Measurements were taken in a seated position with knee and ankle at right angles and feet resting on the floor (Debette et al., 2008).

In terms of anthropometric measurements, values for intraobserver technical error of measurement and coefficient of reliability were .73–.95 and .98–.99, respectively (Ulijaszek & Kerr, 1999). The first author, a trained nurse, collected anthropometric data using a standardized protocol described above. Anthropometric measures were performed using a nonelastic but flexible plastic tape. Data used in analysis were the computed mean of two repeated measurements.

Univariate analysis showed calf circumference as significantly correlated with other nutritional anthropometric makers ($r = .706$, $p < .0001$, with BMI; Bonnefoy, Jauffret, Costka, & Jusot, 2002). Intraclass correlation coefficients were >.99, with subjects’ mid-upper arm circumference measurements (Wijnhoven et al., 2010).

### Procedures

Data were collected between July 2008 and August 2009. The institutional review board of the National Taipei University of Nursing and Health Sciences gave prior approval to this study, and researchers obtained agreements to participate from the eight LTCFs in Taipei City. Written information explaining the study was given to LTCF chairpersons and elderly residents or their families before signing the consent form. Subjects were enrolled only after they provided informed consent. By law, the LTCF is responsible to schedule all resident health and blood examinations and maintain all resident records (Department of Social Affairs Ministry of the Interior, 2007). For residents who died during the study year, the LTCF director called the individual’s family members to confirm their consent to participate before researchers contacted them to explain study purpose. Researchers gathered study-related data from medical record after family member(s) had provided informed consent.

### Data Analysis

Collected data were encoded and edited using Microsoft Excel, and statistical analyses were performed through SPSS 17.0 (SPSS, Inc., Chicago, IL, USA) statistical software. Statistical methods such as frequency distribution, percentage, mean, standard deviation, McNemar’s Test, independent sample $t$ test, one-way ANOVA, logistic regression, and generalized linear models were used to analyze the correlation between subjects’ nutritional status and physical function and hospitalization status. A chi-square test, Pearson’s product–moment correlation, Goodman–Kruskal Tau coefficient, and Kaplan–Meier method analyzed subjects’ nutritional and survival status.

### Results

#### Demographic Profile

The 174 subjects in this study were between 67 and 105 years of age (mean $= 82.5$ years; $SD = 7.3$ years). Most were men, 43.1% were over the age of 85 years, and most received nasal-gastric tube feeding. Subjects had a mean of 2.1 ($SD = 1.0$) cardiac diseases. Most subjects (68.4%) experienced primarily chronic vascular diseases. Subjects were on an average of 5.4 different medications ($SD = 2.2$), with the highest-use subject on 11 medications. Subjects’ physical functions were classified based on Barthel index scores. Mean Barthel index scores at the start and end of this 1-year study were 20.5 ($SD = 31.7$) and 17.1 ($SD = 28.6$), respectively, identifying most of the subjects as completely dependent. A total of 23 subjects (13.2%) died during the study period and were not included in the follow-up data (Table 1).

#### Anthropometry and Laboratory Tests

Anthropometry and nutritional status data for subjects included physiological indices at the beginning ($N = 174$) and end ($n = 151$; 23 subjects died within a year) of the study. These indices included BMI, calf circumference, hemoglobin level, albumin level, and total cholesterol level (Table 2). Most subjects had normal BMI ($\geq 18.5$ kg/m$^2$); study start: 157 subjects [90.2%] vs. study end: 139 subjects [79.9%]) and experienced decreased calf circumference (<31 cm). Mean calf circumference was 27.1 cm ($SD = 4.2$) and 26.7 cm ($SD = 4.1$), respectively, at the start and end of the study. Sixteen subjects experienced statistically significant ($p = .012$) decreases in calf circumference (changing from meeting the standard to not meeting the standard). The subjects’ hemoglobin levels were normal (male: 12 g/dl, female: 10 g/dl; study begins: 133 subjects [76.4%] vs. study ends: 119 subjects [68.4%]). Most subjects had normal albumin levels (study begins: 132 subjects [75.9%] vs. study ends: 112 subjects [64.6%]). Mean total cholesterol level was also normal (study begins: 160 subjects [92%] vs. study ends: 141 subjects [81%]).

#### Physical Function

Results showed most subjects ($n = 145$) had not experienced changes in physical function within a 1-year period, although eight subjects did. Four subjects changed from moderately dependent to severely dependent, two subjects changed from moderately dependent to completely dependent, and
two subjects changed from severely dependent to completely dependent. Statistics showed a significant difference ($p = .046$) in subject physical function within the year.

### Hospitalization and Survival Status

In this study, between July 1, 2008, and August 31, 2009, 61 subjects (35.1%) were hospitalized. Most subjects were hospitalized once (32 subjects, 18.4%), with 19 subjects hospitalized twice and 8 subjects hospitalized thrice. Mean days of hospitalization for all subjects and those who had been hospitalized during the study period were 6.86 and 19.72 ($SD = 12.75$ and 14.73), respectively. In terms of reasons for hospitalization, most were hospitalized because of infection (57 subjects, 93.4%), and the second largest number of subjects were hospitalized for respiratory diseases (11 subjects, 18%). Among the subjects hospitalized twice, five were hospitalized because of infection and their hospital stays lasted for more than 20 days.

Among the 174 subjects enrolled in this study, most had survived the year (151 subjects, 86.8%) whereas 23 of them (13.2%) had died. The main cause of death was cardiopulmonary failure (9 subjects, 39.1%), followed by infection (5 subjects, 21.7%).

### Correlation Between Nutritional Status and Survival

An analysis of subject survival showed survival significantly correlated with gender, physical function status, calf circumference, and hemoglobin levels. Female mortality was higher than male mortality (15 vs. 8, $p = .025$). Number and types of medications used ($r = -.15, p = .043$) and physical function status ($r = -.15, p = .05$) were negatively correlated with survival status. Calf circumference ($\chi^2 = 7.47, p = .003$) and hemoglobin level ($\chi^2 = 5.84, p = .031$) correlated positively with survival status. A Goodman–Kruskal Tau analysis found that gender ($G-K Tau = .03, p = .022$), physical function status ($G-K Tau = .04, p = .026$), calf circumference ($G-K Tau = .04, p = .006$), and hemoglobin level ($G-K Tau = .03, p = .016$) significantly correlated with survival status (Table 2).
Correlation Between Feeding Patterns and Hospitalization Status

We categorized the nutritional status of subjects into three groups (static, increasing, and declining) based on changes over the year. Results showed feeding patterns of subjects to correlate significantly with number of hospitalizations during the period. Subjects who received tube feeding were hospitalized more frequently than subjects who received oral feeding ($t = -2.77$, $p = .006$). In addition, feeding pattern correlated significantly to total number of hospitalization days during the year. Total number of hospitalization days

### TABLE 2.
Correlations Between Survival Status and Demographic Characteristics and Nutritional Status ($N = 174$)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Alive</th>
<th>Dead</th>
<th>$n$</th>
<th>$r/\chi^2$</th>
<th>$p$</th>
<th>G-K Tau</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>91</td>
<td>8</td>
<td>99</td>
<td>5.29</td>
<td>.025*</td>
<td>.03</td>
<td>.022*</td>
</tr>
<tr>
<td>Female</td>
<td>60</td>
<td>15</td>
<td>75</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>65–74 years</td>
<td>27</td>
<td>3</td>
<td>30</td>
<td>0.07</td>
<td>.354</td>
<td>.01</td>
<td>.628</td>
</tr>
<tr>
<td>75–84 years</td>
<td>61</td>
<td>8</td>
<td>69</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>≥85 years</td>
<td>63</td>
<td>12</td>
<td>75</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feeding pattern</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orally fed</td>
<td>69</td>
<td>10</td>
<td>79</td>
<td>0.04</td>
<td>1.000</td>
<td>.00</td>
<td>.843</td>
</tr>
<tr>
<td>Tube fed</td>
<td>82</td>
<td>13</td>
<td>95</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of chronic diseases</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No and 1 chronic disease</td>
<td>45</td>
<td>8</td>
<td>53</td>
<td>0.02</td>
<td>.753</td>
<td>.01</td>
<td>.621</td>
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<tr>
<td>2 chronic diseases</td>
<td>61</td>
<td>6</td>
<td>67</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 chronic diseases</td>
<td>35</td>
<td>7</td>
<td>42</td>
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<td>≥4 chronic diseases</td>
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<td>2</td>
<td>12</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Number of medications used</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>≤3 medications</td>
<td>25</td>
<td>8</td>
<td>33</td>
<td>-0.15</td>
<td>.043*</td>
<td>.03</td>
<td>.095</td>
</tr>
<tr>
<td>4–6 medications</td>
<td>72</td>
<td>10</td>
<td>82</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥7 medications</td>
<td>54</td>
<td>5</td>
<td>59</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical function (1 year before)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Completely independent and mildly dependent</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>-0.15</td>
<td>.050*</td>
<td>.04</td>
<td>.026*</td>
</tr>
<tr>
<td>Moderately dependent</td>
<td>21</td>
<td>3</td>
<td>24</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severely dependent and completely dependent</td>
<td>127</td>
<td>17</td>
<td>144</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nutritional status (start of study)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m$^2$)</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Normal, ≥18.5</td>
<td>137</td>
<td>20</td>
<td>157</td>
<td>0.46</td>
<td>.451</td>
<td>.00</td>
<td>.501</td>
</tr>
<tr>
<td>Poor (decreased), &lt;18.5</td>
<td>13</td>
<td>3</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Missing value$^a$</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Calf circumference (cm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal, ≥31</td>
<td>38</td>
<td>0</td>
<td>38</td>
<td>7.47</td>
<td>.003**</td>
<td>.04</td>
<td>.006**</td>
</tr>
<tr>
<td>Poor (decreased), &lt;31</td>
<td>112</td>
<td>23</td>
<td>135</td>
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<td></td>
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<tr>
<td>Missing value$^a$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hemoglobin (g/dl)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male, ≥12; female, ≥10</td>
<td>120</td>
<td>13</td>
<td>133</td>
<td>5.84</td>
<td>.031*</td>
<td>.03</td>
<td>.016*</td>
</tr>
<tr>
<td>Male, &lt;12; female, &lt;10</td>
<td>31</td>
<td>10</td>
<td>41</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Albumin (g/dl)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥3.5</td>
<td>117</td>
<td>15</td>
<td>132</td>
<td>1.64</td>
<td>.201</td>
<td>.01</td>
<td>.202</td>
</tr>
<tr>
<td>&lt;3.5</td>
<td>34</td>
<td>8</td>
<td>42</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Total cholesterol (mg/dl)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥125</td>
<td>139</td>
<td>21</td>
<td>160</td>
<td>.02</td>
<td>1.000</td>
<td>.00</td>
<td>.902</td>
</tr>
<tr>
<td>&lt;125</td>
<td>12</td>
<td>2</td>
<td>14</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Note. BMI = body mass index.

$^a$Subject who had leg amputated.

*p < .05. **p < .01.
for subjects who received tube feeding were more than that for subjects who received oral feeding ($t = -3.49, p = .001$; Table 3).

### Table 3.

**Correlation Between Eating Patterns and Hospitalization Status During the Study Period (N = 174)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Times of Hospitalization</th>
<th>Total Number of Hospitalization Days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Eating pattern</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orally fed (79)</td>
<td>0.38</td>
<td>0.79</td>
</tr>
<tr>
<td>Tube fed (95)</td>
<td>0.77</td>
<td>1.06</td>
</tr>
</tbody>
</table>

Note. *Independent sample t test.* **p < .01.

### Predictors of Hospitalization Status and Survival

We further analyzed predictors affecting the hospitalization status of subjects. Hospitalization was used as the dependent variable whereas gender, age, eating pattern, number of chronic diseases, number, and type of medications, physical function status, and nutritional status at the start and end of the 1-year study period were used as independent variables for stepwise logistic regression analysis. Among hospitalization status predictors, only age and eating pattern had a significant effect. Risk of hospitalization increased 1.01 times with each 1-year increment in subjects’ age (95% CI: 1.06, 1.11). The risk of hospitalization for tube-fed subjects was 1.5 times that of their orally fed peers (95% CI: 2.96, 5.86). Using generalized linear models for analysis, we found that tube feeding is a predictor of the total number of hospitalization days ($p = .007$, 95% CI: $-10.20$, $-1.59$). The mean total number of hospitalization days for tube-fed subjects of 5.9 days ($SD = 2.2$) was significantly more than that for orally fed subjects.

The Kaplan–Meier method was used in survival analysis on the variables of age, eating pattern, and nutritional status, and the subjects’ mortality over the study year was calculated. In terms of stratification variables, mortality in subjects with good nutrition (calf circumference $> 31$ cm) was significantly lower than that in malnourished subjects (calf circumference $< 31$ cm, $p = .008$). As for hemoglobin level, mortality in subjects with good nutrition (hemoglobin level: male, 12; female, 10) was also significantly lower than that in malnourished subjects (hemoglobin level: male, <12; female, <10; $p = .012$; Table 4).

### Discussion

Despite major improvements in elderly care, prevention of malnutrition remains a major challenge. It is vital that healthcare institutions are aware of the issue of elderly malnutrition and provide sufficient training and education to all healthcare staff (Singh et al., 2010).

**Nutritional Status and Physical Function**

Previous studies have shown that physical deterioration accompanied by aging directly or indirectly restricted the quantity and quality of elderly diet and caused dystrophy or malnutrition (Chen, 2007; Visvanathan et al., 2004). In this study, our follow-up on changes in subjects’ Barthel index scores showed a significant change in subjects’ physical function over the year. Physical function status and nutritional status were further analyzed, and correlations were found. We identified physical function as significantly correlated with calf circumference and cholesterol level. Kikafunda and Lukwago (2005) randomly selected 100 old people and found poorer nutritional status in subjects with poorer physical function, disabilities, and tube feeding. Chen, Tang, Wang, and Huang (2009) performed a follow-up on 306 hospitalized elderly patients and found changes in ADL to indirectly affect their nutritional status. Results of the current study are consistent with those of previous studies, suggesting poor nutritional status in elderly subjects with poor physical function status.

In terms of the physical functions of subjects enrolled in this study, most were completely dependent. This suggested that subjects living in LTCFs generally needed assistance for physical activities. As for relevant studies in Taiwan, Lai (2007) conducted a study on a specific veteran’s nursing home and found 73 of 160 subjects (45.6%) as completely dependent. Shyu et al. (1993) conducted a study of 143 elderly residents living in 37 LTCFs and found that 36.4% were completely dependent and reliant on assistance for nutritional intake.

Volkert and colleagues (2011) found 57.7% of tube-fed residents in nursing home to be malnourished. In this study, the feeding pattern of subjects was primarily by tube feeding. Further analysis indicated eating pattern as correlated to nutritional status and significantly correlated to calf circumference, albumin level, and total cholesterol level. Lin (2000) and Su (2005) indicated in their studies on LTCFs...
and nursing homes in central and southern Taiwan that old people experienced a high level of malnutrition. In addition, the overall nutritional status of orally fed old people was better. Huang et al. (2005) investigated 1,385 hospitalized tube-fed patients and found that blood albumin of 72.8% of subjects was lower than 3.5 mg/dl and the proportion of malnourished tube-fed patients was higher than the overall hospitalized patient population. Kikafunda and Lukwago (2005) selected 105,100 adults aged 60–90 years as subjects and found that as many as 33% had difficulty eating and experienced disabilities related to malnutrition. Portero-McLellan and colleagues (2010) also found a positive correlation between patient calf circumference and nutritional status, indicating this measurement as a potential complementary tool for monitoring elderly inpatient nutritional status. Our study found decreased calf circumference as the most significant symptom of malnutrition in our study population. Further analysis found eating pattern, physical function status, and calf circumference as significantly correlated with one another. Cuervo, Garcia, et al. (2009) used a nutritional assessment scale to screen 22,007 old people living in communities and found calf circumference as an important index of malnutrition. Lai (2007) interviewed 160 veteran servicemen and found that as many as 80% of residents experienced malnutrition or were at risk of malnutrition, with calf circumference as the primary nutritional status predictor. Chiu et al. (2005) collected information on 280 LTCF residents and found eating pattern and physical function to be predictors of nutritional status. In this study, most tube-fed old people exhibited a higher level of dependence. Subjects needed to rely on assistance for feeding, which resulted in unbalanced nutrient intake. Moreover, subjects might experience muscular dystrophy and degeneration characterized by gradually decreasing calf circumference due to being bedridden and inability to walk independently, which also further enhanced malnutrition risks.

**Correlation Between Nutritional and Hospitalization Statuses**

Volkert and colleagues (2011) found that malnutrition significantly related to nausea/vomiting, constipation, pressure

### TABLE 4.
**Survival Analysis of Subjects’ Demographic Characteristics and Nutritional Status (N = 174)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Alive</th>
<th>Dead</th>
<th>n</th>
<th>Log-Rank Test</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td>0.88</td>
<td>.646</td>
</tr>
<tr>
<td>65–74 years</td>
<td>27</td>
<td>3</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>75–84 years</td>
<td>61</td>
<td>8</td>
<td>69</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥85 years</td>
<td>63</td>
<td>12</td>
<td>75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eating pattern</td>
<td></td>
<td></td>
<td></td>
<td>0.04</td>
<td>.849</td>
</tr>
<tr>
<td>Orally fed</td>
<td>69</td>
<td>10</td>
<td>79</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tube fed</td>
<td>82</td>
<td>13</td>
<td>95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nutritional status (1 year before)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td></td>
<td></td>
<td></td>
<td>0.48</td>
<td>.488</td>
</tr>
<tr>
<td>Normal, 18.5</td>
<td>137</td>
<td>20</td>
<td>157</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor (decreased), &lt;18.5</td>
<td>13</td>
<td>3</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Missing value a</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Calf circumference (cm)</td>
<td></td>
<td></td>
<td></td>
<td>7.07</td>
<td>.008**</td>
</tr>
<tr>
<td>Normal, 31</td>
<td>38</td>
<td>0</td>
<td>38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor (decreased), &lt;31</td>
<td>112</td>
<td>23</td>
<td>135</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Missing value a</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Hemoglobin (g/dl)</td>
<td></td>
<td></td>
<td></td>
<td>6.24</td>
<td>.012*</td>
</tr>
<tr>
<td>Normal (male, 12; female, 10)</td>
<td>120</td>
<td>13</td>
<td>133</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor (decreased) (male, &lt;12; female, &lt;10)</td>
<td>31</td>
<td>10</td>
<td>41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Albumin (g/dl)</td>
<td></td>
<td></td>
<td></td>
<td>1.664</td>
<td>.197</td>
</tr>
<tr>
<td>Normal, 3.5</td>
<td>117</td>
<td>15</td>
<td>132</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor (decreased), &lt;3.5</td>
<td>34</td>
<td>8</td>
<td>42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total cholesterol (mg/dl)</td>
<td></td>
<td></td>
<td></td>
<td>0.001</td>
<td>.975</td>
</tr>
<tr>
<td>Normal, 125</td>
<td>139</td>
<td>21</td>
<td>160</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor (decreased), &lt;125</td>
<td>12</td>
<td>2</td>
<td>14</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. BMI = body mass index.

*a* Subject who had leg amputated.

* p < .05. ** p < .01.
ulcers, dehydration, infections, antibiotic use, and hospitalization. In this study, we also found subjects’ eating patterns significantly correlated with hospitalization status over the year. Admission frequencies and total number of hospitalization days were greater for tube-fed than orally fed subjects. Although this study was unable to verify a direct correlation between nutritional and hospitalization statuses, eating pattern was correlated with nutritional status as well as calf circumference, albumin level, and total cholesterol level. This infers nutritional status, albumin level, and total cholesterol level as indirectly correlated with hospitalization status over the year. Seiler (2001) found that old people who were hospitalized, living in nursing homes, or living at home tended to experience malnutrition and that malnutrition increased admission frequency. Stratton and Elia (2006) screened the nutritional status of 1,000 old people and found that as many as 42% faced a high risk of malnutrition during hospitalization. Malnutrition was significantly correlated with prolonged hospital stays. Correia and Waitzberg (2003) found the average number of hospitalized days for adults with poor nutritional status to be longer than those with good nutritional status (16.7 vs. 10.1 days).

Previous studies have indicated that tube feeding leads to aspiration pneumonia (Metheny, 2006; Metheny, Stewart, & McClave, 2011). Most of our subjects were tube fed. The main reason for hospitalization was pneumonia, and we found tube feeding as correlated with hospitalization status. Health professionals should further examine this phenomenon and carefully assess nutrition and health statuses when caring for tube-fed individuals.

**Relationship Between Nutritional and Survival Statuses**

This study found gender, physical function status, calf circumference, and hemoglobin level to be significantly correlated with survival. While female deaths outnumbered male deaths in our subject population, a relationship between gender and survival could not be verified as male subjects outnumbered female subjects (99:75). This ratio differed significantly from most of other similar studies, which included more female subjects than male subjects (Carriere, Dupuy, Lacrous, Cristol, & Pelcourt, 2008; Harris, Davies, Ward, & Haboubi, 2008; Portero-Mcellean et al., 2010). Number and type of medications used and physical function status were negatively correlated with survival. The uneven distribution of number and type of medications used and physical function status resulted in increased subjects’ deaths in those taking three medications as compared with those who were completely independent or only mildly dependent. As such, correlations among number and type of medications used, physical function status, and survival could not be verified by this study.

Analysis of subjects’ nutritional status and survival revealed calf circumference and poor nutritional status as measured by decreased hemoglobin level to correlate positively with survival. This finding was consistent with relevant studies. Some studies have indicated that calf circumference is an important predictor of nutritional status (Lai, 2007; Cuervo, Ansorena, et al., 2009). Decreased hemoglobin level implied insufficient protein intake, which leads to greater risk of malnutrition-related mortality (Fontaine & Raynaud-Simon, 2008). Correia and Waitzberg (2003) found mortality among malnourished elderly subjects to be 2.63 times that of subjects with good nutrition. Drame et al. (2009) conducted a study on 1,306 elderly patients hospitalized after emergency room visits and found that malnutrition correlated with mortality within 3 years. In this study, most subjects with decreased calf circumference were also severely dependent and primarily tube fed. Decreased hemoglobin level was correlated with insufficient protein intake. This infers that severe dependence leads to muscular dystrophy and degeneration, which further increases the risk of decreased calf circumference. Subjects who failed to take food by themselves due to severe dependence had less nutrient intake, increased malnutrition, and increased mortality.

**Predictive Power of Nutritional Status on Hospitalization and Mortality**

In this study, the predictors of subjects’ hospitalization were primarily age and eating pattern. Every increase of 1 year in age increased subjects’ risk of hospitalization by 1.01 times. Risk of hospitalization for tube-fed subjects was 1.5 times higher than that for their orally fed peers. Total number of hospitalization days for tube-fed subjects during the study year were higher than that of orally fed subjects, indicating that tube feeding may be an important predictor of hospitalization. In this study, eating pattern correlated significantly with calf circumference, albumin level, and total cholesterol level, inferring that these three variables were indirect predictors of hospitalization. Sorensen et al. (2008) assessed the nutritional status of 5,051 subjects enrolled at 26 hospitals in 12 countries and found that elderly participants aged ≥70 years had more days of hospitalization. In terms of predictors of survival for elderly subjects living in LTCFs, the mortality rate of subjects with normal calf circumference was less than that of subjects with decreased calf circumference. Mortality in subjects with normal hemoglobin levels was lower than that in subjects with decreased levels. Yang’s (2004) investigation of mortality and nutritional status among 276 tube-fed patients found hemoglobin level as a significant predictor of mortality. Sorensen et al. (2008) also found that both mortality and days of hospitalization were higher in malnourished than nonmalnourished subjects.

**Limitations**

Data in this study were collected from medical chart records. Although all facilities used the same brand chair
scale, the potential for interfacility measurement error remains. Also, researchers did not perform the knee length estimates of height, calf circumference measurements, and physical function Barthel index assessments, which may introduce inconsistencies in obtained data.

Most subjects in this study were completely dependent. Measuring knee length was complicated because of stiff limbs and joint contraction, which may have affected BMI data accuracy. This study was designed as a retrospective study, and it was difficult to obtain informed consent to access data on subjects who had died. The number of subjects who died may be underestimated, which could affect overall results. In addition, based on survival analysis selection, when comparing the nutritional status of subjects who are still alive after a year with that of those who died within that year, we found that the former had better nutritional status at the points in the year immediately before the death of subjects in the latter category. Thus, results should only be applicable for predictions related to elderly LTCF resident alive more than 1 year after enrollment.

Conclusions
The subjects enrolled in this study were primarily tube fed, experienced multiple diseases, were completely dependent in terms of physical function, and were concurrently taking multiple medications. Physical function status for subjects was largely “completely dependent.”

Care in applying tube feeding is an issue worth further examination and consideration. Results of the current study show hospitalization over the year to correlate with tube-feeding status. Aspiration pneumonia was found to be the most common cause for hospitalization of tube-fed subjects. Calf circumference and hemoglobin level correlated positively with survival status. Decreased hemoglobin level correlated with insufficient protein intake. Further investigation into proper nutrition protocols for elderly residents of LTCFs is recommended. There is little data on calf circumferences in Taiwan’s elderly population, and data used in most Taiwan studies drew primarily on foreign study data. We thus recommend a stronger effort in Taiwan to collect representative samples that can be used in further analyses and to establish culture-specific data that enables calf circumference to be used as a simple and convenient index for measuring nutritional status.

Relevance to Clinical Practice
For those in the healthcare profession, results of the current study suggest the following: (a) Subjects with poorer physical function status exhibited decreased calf circumference and malnutrition. Maintenance of physical function also correlated closely with the maintenance of subjects’ nutritional status. Therefore, we advise care facilities to strengthen rehabilitation exercise programs for residents, arrange regular rehabilitation therapist visits, and provide rehabilitation assistance. (b) Calf circumference, hemoglobin level, albumin level, and cholesterol level were important predictors of hospitalization and death. It is advised that, in addition to regular follow-up on health examination hematological reports, care facilities should also increase follow-up on calf circumference to reduce malnutrition-related hospitalization and death risks and medical costs. (c) Most residents in the study were tube fed. LTCF staffs are advised to understand how aggressive intervention using nutritional support and improvement measures can help balance and stabilize residents’ nutritional intake. Moreover, nutrition-related in-service training for relevant staff should be strengthened to increase the quality of resident care. (d) This study found that tube feeding correlated with hospitalization. We recommend convening discussions involving professionals, family members of elderly residents, and LTCF caregivers to consider the benefits of employing other eating patterns such as gastrostomy to decrease aspiration pneumonia-related hospitalization incidences. (e) LTCF nursing staffs must be professional and independent. Nursing education should strengthen nursing staff assessment of residents’ nutritional statuses to increase sensitivity to identify residents at high risk of malnutrition and execute timely prevention and treatment. Moreover, strengthening interteam cooperation is necessary.

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nutritional risk screening and evaluate clinical outcome. 


養護機構老人營養狀況與身體功能、住院次數、住院天數及死亡之相關性探討

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背景
養護機構中，老人營養狀況的問題普遍存在，在台灣，長期照護機構老人營養不良比率高達20%。

目的
本研究之目的為調查養護機構中老人營養狀況、身體功能、住院次數、住院天數、死亡情形及其相關性。

方法
採回溯性研究設計和方便取樣方式收案174位，年齡為67歲-105歲（平均年齡：82.5
）, 居住於台北市北投區合法立案之養護機構的住民，由病歷中查詢研究所需
之基本資料資料、過去一年的健康檢查抽血報告、體位測量、身體功能、住院次
數、住院天數及死亡原因進行資料收集。研究對象自收案日期回溯入住養護機構達
一年以上，含回溯入住一年當中已死亡之個案。

結果
結果顯示，過去一年中，養護機構老人在身體功能狀況及小腿圍的變化較明顯，且身
體功能狀況與小腿圍具有顯著相關。過去一年的住院狀況與管灌飲食有相關，而進食
方式與小腿圍、白蛋白值、膽固醇值具有顯著相關。推論營養狀況中，小腿圍、白蛋
白值、膽固醇值與過去一年住院狀況有間接相關。本研究中，年紀越大與管灌飲食的
個案，越有住院發生的可能性，且管灌飲食的個案住院天數也較長。此外，小腿圍與
血色素營養狀況不良個案與死亡有相關性。

結論／實務應用
透過研究結果，建議機構需要更加重視養護機構老人營養狀態，以減少住院及死亡之
情形發生，進而能減少其他相關的醫療費用，提升照護品質。

關鍵詞：養護機構、營養狀況、住院次數、住院天數、死亡。

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