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**Factors associated with increased hospitalization risk among nursing home residents in  
Sweden: a prospective study with a three-year follow-up**

Jenny Hallgren,<sup>1,2</sup> RN MsC; Marie Ernsth Bravell,<sup>1</sup> RN PhD; Sigvard Mölsted,<sup>3</sup> MD PhD;  
Carl Johan Östgren,<sup>4</sup> MD PhD; Patrik Midlöv,<sup>3</sup> MD PhD; Anna K. Dahl Aslan,<sup>1,5</sup> PhD

<sup>1</sup>Institute of Gerontology, School of Health and Welfare, Jönköping University, 551 11

Jönköping, Sweden

<sup>2</sup>Regional Development Council of Jönköping County, 551 14 Jönköping, Sweden

<sup>3</sup>Lund University, Department of Clinical Sciences, Malmö, Sweden

<sup>4</sup>Department of Medical and Health Sciences, Linköping University, Linköping Sweden

<sup>5</sup> Department of Medical Epidemiology and Biostatistics, Karolinska Institutet, 171 77

Stockholm, Sweden

**Correspondence to:**

Jenny Hallgren, Institute of Gerontology, School of Health and Welfare, Jönköping University,  
551 11 Jönköping, Sweden

Phone: +46 702476768; E-mail: [jenny.hallgren@ju.se](mailto:jenny.hallgren@ju.se)

Alternative corresponding author: [anna.dahl@ki.se](mailto:anna.dahl@ki.se)

Running head: Hospitalization risk in nursing homes

## **Conflict of interest**

None declared.

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## **Author Contributions**

J.H and A.K.D.A were responsible for drafting the manuscript and analyzing the data. M.E.B, S.M, C.J.Ö, and P.M were responsible for planning and collecting the data. All authors are responsible for the intellectual content of the manuscript.

## **SUMMARY STATEMENT**

**What does this research add to existing knowledge in gerontology?**

- **Despite access to health care around the clock, nursing home residents are often malnourished or at risk of malnutrition, and often hospitalized.**
- **The main reasons for nursing home residents to be hospitalized are cardiovascular disease and complications due to falls.**
- **Malnutrition, previous falls, more drugs and multimorbidity are associated with greater hospitalization risk among nursing home residents.**

**What are the implications of this new knowledge for nursing care with older people?**

- **Prevention of falls, malnutrition and pressure sores are important nursing tasks and successful prevention might reduce the number of hospitalizations among nursing home residents.**
- **Knowledge about residents with increased risk of hospitalization could be used to guide nursing home nurses both in preventive work, but also in hospital decision making judgements.**

**How could the findings be used to influence policy, practice, research or education?**

- **Biological ageing in combination with polypharmacy and multimorbidity are important indicators of frailty, as well as risk factors of hospitalization implying that there is a need for gerontological and geriatric knowledge in nursing homes.**
- **There is a need for regular risk assessments and prevention programs to reduce states associated with avoidable hospitalizations in nursing homes.**

- **Future research should study if numbers of avoidable hospitalizations could be reduced by interventions targeting falls and malnutrition.**

## **ABSTRACT**

**Background:** Hospitalization of nursing home residents might lead to deteriorating health.

**Objectives:** To evaluate physical and psychological factors associated with hospitalization risk among nursing home residents.

**Design:** Prospective study with three years of follow-up.

**Methods:** 429 Swedish nursing home residents, ages 65-101 years, from 11 nursing homes in three municipalities were followed during three years. The participants' physical and psychological status was assessed at baseline. A Cox Proportional Hazards model was used to evaluate factors associated with hospitalization risk using STATA.

**Results:** Of the 429 participants, 196 (45.7%) were hospitalized at least once during the three-year follow-up period, and 109 (25.4%) during the first six months of the study. The most common causes of hospitalization were cardiovascular diseases (CVD) or complications due to falls. A Cox regression model showed that residents who have had previous falls ( $p = 0.008$ ), are malnourished ( $p = 0.002$ ), use a greater number of drugs ( $p = 0.023$ ), have had more diseases ( $p = 0.004$ ), and have higher levels of serum transferrin ( $p = 0.001$ ) are at an increased risk of hospitalization.

**Conclusion:** Nursing home residents are frequently hospitalized, often due to falls or CVD. Study results underscore the relationships between malnutrition, previous falls, greater numbers of drugs and diseases, and higher levels of serum transferrin and higher risk of hospitalization.

**Implications for Practice:** Preventive interventions aimed at malnutrition and falls at the nursing home could potentially reduce the number of hospitalizations, and in the long run improve the quality of life and reduce suffering as well as costs.

**Key words:** Nursing home residents; Hospitalization; Prospective design; Mini Nutritional Assessment; Falls

## **Introduction**

Nursing home residents are often hospitalized. In general more than 15% of long stay nursing home residents are hospitalized within a six month period (Intrator et al., 2007; Intrator, Zinn, & Mor, 2004). Many hospitalizations are believed to be avoidable and better treated outside the hospital, not least for nursing home residents that often are frail. It has been shown that hospitalization among nursing home residents can cause iatrogenic disorders, confusion, falls, and nosocomial infections leading to serious consequences (Charette, 2003; Creditor, 1993; Grabowski, Stewart, Broderick, & Coots, 2008). Nursing home residents are often more physically and cognitively impaired when they return to the nursing home than they were before the hospital admission (Boltz, Capezuti, Shabbat, & Hall, 2010; Gill, Gahbauer, Han, & Allore, 2009; Ouslander, Weinberg, & Phillips, 2000). From this perspective, prevention of nursing home residents' hospitalization is important to reduce unnecessary suffering.

Previous studies suggest that increasing age, reduced physical function (Carter, 2003a; Grabowski et al., 2008), as well as polypharmacy (Albert, Colombi, & Hanlon, 2010; Flaherty, Perry III, Lynchard, & Morley, 2000) are associated with an increased risk of hospitalization. Specific clinical conditions as congestive heart failure (CHF), circulatory problems, respiratory problems and genitourinary problems have also been related to an increased risk of hospitalization in nursing home residents (Carter, 2003b; Carter & Porell, 2005).

Currently, the predictive values of risk assessment tools that are increasingly used in nursing homes, such as the Mini Nutritional Assessment (MNA) or the Mini-Mental State Examination (MMSE), are not well researched in relation to hospitalization risk. Further, current knowledge is mainly based on cross-sectional studies including few risk factors, limiting the possibility of identifying factors that may be addressed by long-term preventive actions. Last but not least,

the current literature is mainly based on findings from the United States. As it is likely that hospitalizations are influenced by health policies and economic concerns (Walsh et al., 2012), it is important to study hospitalization risk factors within other health care systems. Several European countries such as Sweden have high levels of public funded health care (Gelormino, Bambra, Spadea, Bellini, & Costa, 2011) and is an interesting and contrasting example to countries with lower levels of public funded health care. In Sweden access to nursing homes is based on need assessment, and residents are prioritized based on their greater need of care, i.e. those with the most severe functional impairments and multimorbidity receive priority access. In nursing homes, registered nurses and nurse assistants provide health care under specific instruction from primary care physicians who serves as consultants, as nursing homes in Sweden do not have physicians stationed (National Board of Health and Welfare, 2012). Normally primary care physicians' visits the nursing homes once a week and when need arises. The registered nurse stationed at the nursing home make the decision to transfer to a hospital, after consulting the physician. Hence, nurses have an important role in this decision since their judgments are based on recognizing and understanding changes in the resident's physical and/or mental health. Decreasing numbers of avoidable hospitalization, especially from nursing homes has been prioritized in the last decades (Swedish Association of Local Authorities and Regions, 2012). Still a recent study reveal that approximately 16% of Swedish nursing home residents' emergency departments transfer are possibly avoidable (Kirsebom, Hedström, Wadensten, & Pöder, 2014).

As nursing home residents are typically frail and often suffering from multimorbidity, it is important to learn to reduce or avoid unnecessary suffering due to hospitalizations. Therefore, the current study aimed to analyze potential risk factors related to increased risk of hospitalization among nursing home residents. Specifically, physiological and psychological

risk factors were evaluated using risk assessment tools and tests commonly used in nursing home settings.

**Aim**

The aim of this study was to evaluate physical and psychological factors associated with hospitalization risk over time among nursing home residents.

## Method

### Subjects

The current study is based on data from the *Study of Health and Drugs in Elderly living in institutions* (SHADES) (Ernst Bravell et al., 2011). SHADES is a longitudinal, open cohort, multipurpose study including older people in 11 nursing homes in three different municipalities in Sweden.

The nursing homes included 30 general departments and 10 departments focused on dementia care. All residents (N = 443) living in the selected nursing homes were invited to participate. Among those invited, 175 were excluded for various reasons (refusal 58, relatives refusal 31, severe illness 49, communication difficulties 11, no reason given 5, death before study entry 18, <65 years of age 3). At the first assessment, 268 nursing home residents participated, giving a participation rate of 61%. Written informed consent from the participant or next of kin was obtained. The participants were examined every six months over three years (2008-2010), which was considered appropriate intervals to study an older population since changes in health condition occurs rapidly in high ages. Those who ended their participation during the study period (due to death (n=193), migration (n=7), or refusal (n=4)) were replaced by a new resident entering the site in order to maintain a larger sample (Figure 1). In total, 429 persons participated in at least one assessment. The study was approved by the Regional Research Ethics Board in Linköping, Sweden.

*Insert Figure 1 about here*

## **Method**

Three specially trained registered nurses collected data, one in each municipality. They did not work in the nursing homes, but were employed as project nurses for the SHADES study. For this purpose they got training in performing different examinations and to treat the participants adequate. Tests and examinations were conducted at the nursing homes. The participant's health status was assessed with standardized procedures and well-established tests and scales, and based on information using caregivers as proxies. Social services records as well as nurse's documentations were also collected.

## **Outcome variable**

The dates of and reasons for hospitalization during the study period, were extracted from the nurses' documentation at the nursing homes, based on diagnosing codes from the hospital medical records. The outcome variable was a resident's hospitalization, and the time to event was the time from when a resident first enters the study to the first hospitalization. For individuals not subjected to hospital care, the follow up time was to the last assessment in the study, or to the time of death.

## **Independent variables**

### *Health indicators*

Information about the participants' number of medical diagnoses and number of drugs was collected from the medical records and from the nurses' documentation. The research nurses measured weight and blood pressure. Need of care was evaluated by five items assessing dependency in performing Instrumental Activities of Daily Living (IADL) (range 0-20) and five items assessing dependency in performing Personal Activities of Daily Living (PADL) (range 0-20) (Katz, Ford, Moskowitz, Jackson, & Jaffe, 1963), where higher values indicate

higher dependency. The responsible health care assistant or nurse reported physical activity, included how many hours per week a resident conducted physical activity such as walking, balance training or exercises led by a physiotherapist.

### *Risk assessment tools*

A wide set of risk assessment tools that are commonly used in nursing home settings were included. Given the skewed distribution of the scores on these tools, the scores were dichotomized at well-established cut-off points as follows. Downton Fall Risk Index (DFRI) was used to estimate the risk of falling (Downton, 1993). The maximum score is 11, with scores higher than 3 indicating a high risk of falling (Olsson Möller, Kristensson, Midlöv, Ekdahl, & Jakobsson, 2012). Nutritional status was assessed with the Mini Nutritional Assessment (MNA) (Vellas et al., 1999). The maximum score of the Mini Nutritional Assessment-SF (short form) is 14; a score of less than 11 points indicates risk for malnutrition and a score of less than 7 points indicates malnutrition (Rubenstein, Harker, Salvà, Guigoz, & Vellas, 2001). The Modified Norton Scale (MNS) assesses the risk of developing pressure ulcers. The maximum score is 30 and a score of 20 or less indicates an elevated risk of developing pressure ulcers (Ek, Unosson, & Bjurulf, 1989). The Cornell Scale for Depression in Dementia (CSDD) is designed to be used on people with cognitive dysfunction (Alexopoulos, Abrams, Young, & Shamoian, 1988), but has been shown to be equally valid for older persons with or without dementia (Kørner et al., 2006). The maximum score is 38, and a score above 8 indicates depression. The Mini-Mental Status Examination Test is a screening of cognitive ability, with a maximum score of 30 (Folstein, Folstein, & McHugh, 1975), and was dichotomized at 24, which is usually considered to be an indication of cognitive impairments (Grut, Fratiglioni, Viitanen, & Winblad, 1993).

### *Nursing home organizational factors*

The number of registered nurses and of nurse assistants were summed and divided by number of residents to derive a crude staff ratio. The staff ratios were dichotomized at the mean.

### **Statistical Analyses**

We used either a *t*-test or a Chi-square test (using SPSS 19.0) to analyze differences in the baseline characteristics of participants who had been hospitalized during the follow-up period and those who had not. Both bivariate and multivariate Cox proportional hazard regression analyses were performed to evaluate factors associated with hospitalization risk. Variables that were associated with hospitalization risk from the bivariate analyses were included in the multivariate analyses. The Cox proportional hazard regression analyses were performed with STATA with robust standard errors to control for potential dependency within sites, as well as within nursing homes. Continuous variables were standardized using *z*-transformation before analysis, to allow for easier comparisons.

## Results

### Descriptive Statistics

The mean age of the sample was 85 (range 65–101) years and 70.9% of the participants were female. Of the 429 participants, 196 (45.7%) had at least one, 73 (17.0 %) had two and 8 (0.02%) had even five or six hospitalizations during the three-year follow-up period. The most common reasons for admission, according to the medical records, were cardiovascular disease (26%) and complications due to falls (25%). Among cardiovascular diseases, CHF (9.7%) was the most common diagnose, followed by stroke (8.7%). The remaining reasons for hospitalization were infections such as pneumonia, urinary tract infection or sepsis (16%), dementia (12%), disorders of the gastrointestinal tract (11%) and 10% were due to other disorders such as diabetes, anemia or pain related conditions.

Table 1 describes the baseline characteristics and differences between those who were hospitalized during the study period and those who were not. Participants that were hospitalized during the study period had a higher risk of falls and of malnutrition, used more drugs and had more diseases. There was no difference in age, gender, signs of depression, or risk for pressure ulcers at baseline between those who became hospitalized and those who did not. Participants who were enrolled during the study did not differ from the participants who were involved from the study start. Staff ratios did not affect hospitalization risk, but the variance in staff ratios was small both for registered nurses (M=0.03, SD=0.01) and for nurse assistants (M=0.74, SD=0.09).

*Insert Table 1 about here*

Table 1 also presents the results from the bivariate Cox's proportional hazards model for survival. Each variable was analyzed separately, controlling for age, sex, and dependency within sites. A positive regression coefficient implies an increased risk of hospitalization. Nursing home residents with previous falls ( $p < 0.001$ ) and with malnourishment ( $p < 0.001$ ) were at greater risk of hospitalization. Further, hospitalization risk was significantly greater for those residents with a higher number of prescribed drugs ( $p < 0.001$ ) and more diseases ( $p < 0.001$ ).

Variables that were significantly associated with increased risk of hospitalization in the bivariate models were entered into a multivariate Cox proportional hazard regression model (Table 2). The results suggests that nursing home residents with previous falls, malnourishment, and a greater number of diseases and prescribed drugs have increased hospitalization risks, as presented in Figure 2. The Mini-Mental Status Examination Test was however not significantly associated with increased risk of hospitalization. The Cornell Depression Scale was not a significant factor in the multivariate Cox proportional hazard regression model. Post hoc analyses showed that Cornell Depression Scale is correlated with the Mini Nutritional Assessment-short form ( $r = 0.257, p < 0.001$ ). The result also suggests that an increased number of risk factors increase hospitalization risk, as shown in Figure 2e.

*Insert Table 2 about here*

*Insert Figure 2 about here*

## **Discussion**

This study shows that nursing home residents are frequently hospitalized; almost one out of two were hospitalized during this rather short time period of three years. The main findings suggest that nursing home residents with malnourishment, previous falls, more drugs prescribed and multimorbidity are at greater risk of hospitalization over a three year period. Addressing these risk factors could potentially reduce the number of hospitalizations. Nurses are important actors in this work since they are responsible of assessing risk of severe outcomes among nursing home residents.

As mentioned in the introduction, one of the strengths of studying factors associated with hospitalization in Sweden is that the financial incentives to hospitalize nursing home residents are low. The high congruency between the current findings and studies performed on nursing home residents in United States indicates that there are some risk factors that are consistent despite very different health care systems, especially polypharmacy, malnutrition and falls (Carroll, Delafuente, Cox, & Narayanan, 2008; Flaherty et al., 2000; Jensen, Friedmann, Coleman, & Smiciklas-Wright, 2001).

One of the main reasons for hospitalization was the prevalence of and complications from cardiovascular diseases. The single most common reason was CHF. This finding confirms previous findings from different contexts (Condelius, Edberg, Jakobsson, & Hallberg, 2008; Jingping Xing, Mukamel, & Temkin-Greener, 2013; Ouslander, Diaz, Hain, & Tappen, 2011; Swedish Association of Local Authorities and Regions, 2013), and is not very surprising given that cardiovascular diseases often demand acute hospital care. However, hospitalizations due to CHF is considered to be an avoidable hospitalization (Agency for Healthcare Research and Quality), thus these results indicates that knowledge and treatment strategies of heart failure in nursing homes need to be improved.

Another main reason for hospitalization was falls. Despite the fact that the majority of falls in nursing homes are considered to be injury-free, about one in four falls are thought to result in hospital admission (Vu, Weintraub, & Rubenstein, 2006). Although falls might have multifactorial causes, findings in this study highlight the importance of fall prevention and better use of fall risk assessment tools.

The nursing home residents' nutritional status was poor. About 16% of the residents were malnourished and 44% were at risk of malnutrition. Previous international research has shown that malnutrition and eating disorders in older community residents increases the risk of hospitalization (Jensen et al., 2001), and longer hospital stays (Van Nes, Herrmann, Gold, Michel, & Rizzoli, 2001). The current study extends these findings and shows that this is also true for nursing home residents. It has been suggested that lower staff level at the nursing homes is associated with weight loss among the residents (Tamura, Bell, Masaki, & Amella, 2013). Greater risk of hospitalizations should likely be added to the list of negative consequences of malnutrition.

Risk for hospitalization was also associated with the use of a large number of drugs, confirming findings among older people with home care (Flaherty et al., 2000). Polypharmacy is also related to a longer hospital stay and several other outcomes such as mortality, fractures, and institutionalization (Frazier, 2005). The nursing home residents in this study were taking 6.8 drugs on average, confirming the average use of drugs (7.2 drugs) by institutionalized older persons in Sweden, to be compared to community-dwelling individuals taking 4.3 drugs on average (Johnell & Fastbom, 2012). This may of course be an indication that nursing home residents have many health problems, but may also indicate that nursing home residents consume too many and sometimes inappropriate drugs.

Despite access to health care around the clock our study showed that many of the nursing home residents were malnourished (or at risk of malnutrition), had a high number of drugs, and had experienced fall, etc. This is potentially modifiable risk factors and needs to have a high priority in nurses' daily work and in research. One way to make nurses aware of these factors and changes in them might be to implement systematic assessment tools. According to previous research nurses find it useful to use systematic assessment tools in the areas of malnutrition, pressure ulcers, and falls in their daily work in nursing homes as it makes patients caring needs visible (Rosengren, Höglund, & Hedberg, 2012).

According to the medical records, dementia was the fourth most common reason for hospitalization. This support previous studies revealing that 15-16% of nursing home residents with advanced dementia were hospitalized during a period of three months and six months respectively (Givens et al., 2013; Givens, Selby, Goldfeld, & Mitchell, 2012). In Sweden, it is common for nursing home residents to have a diagnosis of dementia (Sund-Levander, Örtqvist, Grodzinsky, Klefsgård, & Wahren, 2003), as dementia is associated with greater care needs. However, it was not possible in this study to find out from the medical records whether hospitalizations due to dementia were actually caused by worsened behavioral symptoms of dementia or symptoms of something else. The majority (60%) of those who were hospitalized due to dementia were not living in a dementia department with specialized staff. This suggests that more beds in dementia departments and/or staff better qualified to care for persons with dementia, or preferably both, could possibly reduce the number of hospitalizations. Future studies should evaluate whether education programs could reduce the number of hospitalizations among nursing home patients with a dementia diagnoses.

It is noteworthy that 40% of those hospitalized due to dementia lived in a dementia department. The overall quality of life should guide the decision to hospitalize a nursing home resident with dementia since unfamiliar hospital environment can be stressful for this population (Givens et

al., 2012). As the current study shows that a dementia diagnose is not protective to hospitalization, periodic advance care planning including discussions of when a hospital event should be considered in nursing homes.

Depression was not associated with an increased risk of hospitalization in the multivariate Cox proportional hazard regression models. Post hoc analyses showed that depression was correlated with the MNA-SF. This association is probably due to overlapping questions relating to weight loss and loss of appetite. It may therefore be possible, or even likely, that depression is also a risk factor of hospitalization. Prior research have found that the residents preferences regarding hospitalization *i.e.* were they prefer acute conditions to be treated, as well as the overall quality of life is the most important factors to hospitalize nursing home residents, even more important than clinical factors such as likelihood of death, discomfort and disability (Buchanan et al., 2006).

Strengths of this current study is its prospective design in a setting where economic incentives are low. The study also includes nursing home residents, a group that has received relatively little attention in research. Few prior studies has used validated risk assessment tools commonly used in nursing homes to study hospitalization risk factors. Furthermore, the use of survival analyzes as the Cox proportional hazard regression model, make it possible to study the importance of each health indicator over a long period of time. The study has limitations; as in all studies involving older people, the selection of the participating nursing homes was based on convenience sampling and on nursing homes positive to improvement work and therefore more likely to participate. However the nursing homes included were typical for Sweden and did not differ from other nursing homes in terms of participants mean age and staffing (Ernst Bravell et al., 2011). Since the nursing homes placement were in three different parts of Sweden increases the chance that they are representative and likely increases the generalizability of the results. Unfortunately there was a rather low participating rate of 61 %, mainly due to the

excluded participants or their relatives refused participation. We have no knowledge of the reasons for their refusal; however, studies conducted on older persons tend to have lower participating rates as drop outs are correlated with health and functional ability (Chatfield, Brayne, & Matthews, 2005). There is also a selection bias, where the healthier nursing homes residents were more likely to participate. On the other hand, this potential bias might be less relevant as the study shows that nursing home residents in general are old and frail. Unfortunately we lack information about length and outcome of the hospitalizations, and whether some of the hospitalizations among the nursing home residents could have been avoided.

## **Conclusion**

In conclusion, despite access to health care nursing home residents are frequently hospitalized, often due to falls or cardiovascular diseases. Malnutrition, previous falls, a greater number of drugs and diseases are also associated with greater risk of hospitalization. The clinical implications from our findings suggest that preventive interventions for malnutrition and falls at nursing homes could likely reduce the number of hospitalizations. With improved education and support to nurses concerning risk assessment at the nursing homes, it may be possible to reduce the numbers of avoidable hospitalization among nursing home residents and in the long run improve quality of life and reduce suffering. How knowledge of risk factors and early signs could guide nurses in their hospital decision making in nursing homes need to be further studied.

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## Figure Caption

**Figure 1.** Flow diagram describing the in- and outflow from the SHADES-study and number of participants in each of the in person testing (IPT), and how many IPT each resident participated in.

**Figure 2.** Kaplan Meier plots. Risk of Hospitalization based on falls (a), nutritional status (b), number of drugs (c), number of diseases (d), and number of risk factors (e).

Figure 1

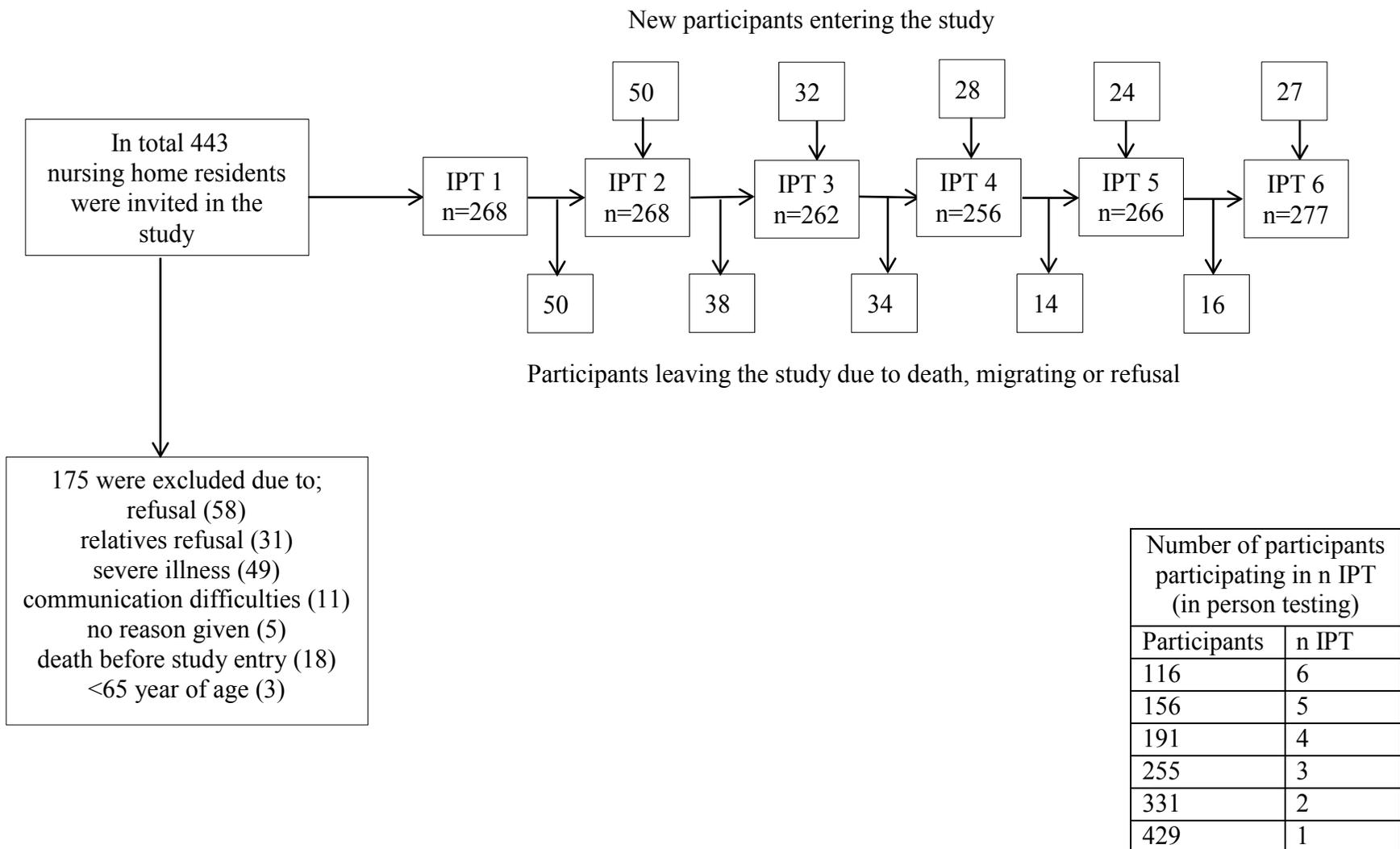


Figure 2a.

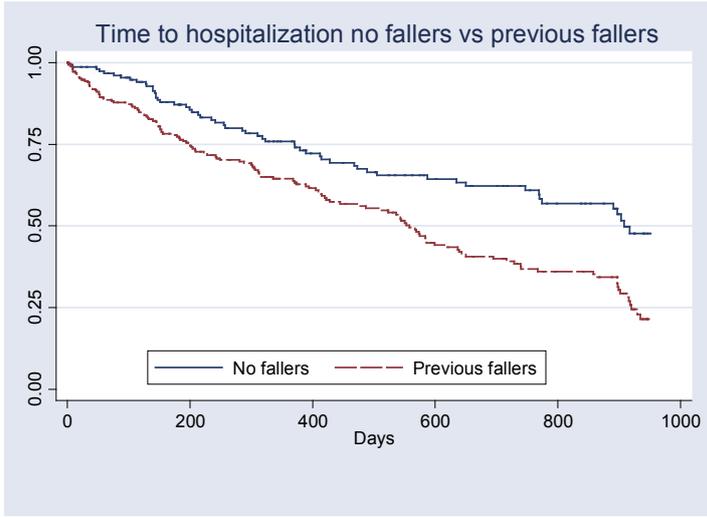


Figure 2b.

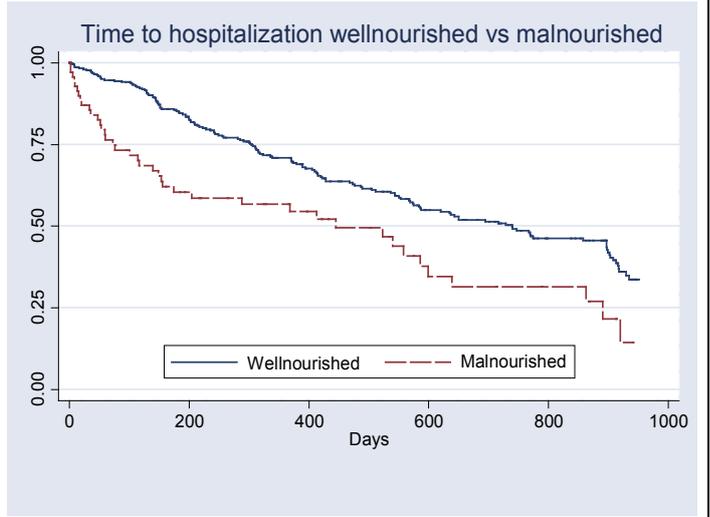


Figure 2c.

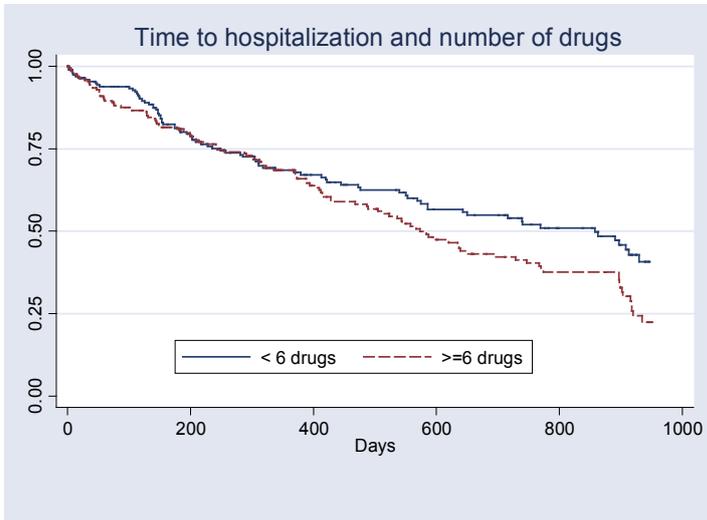


Figure 2d.

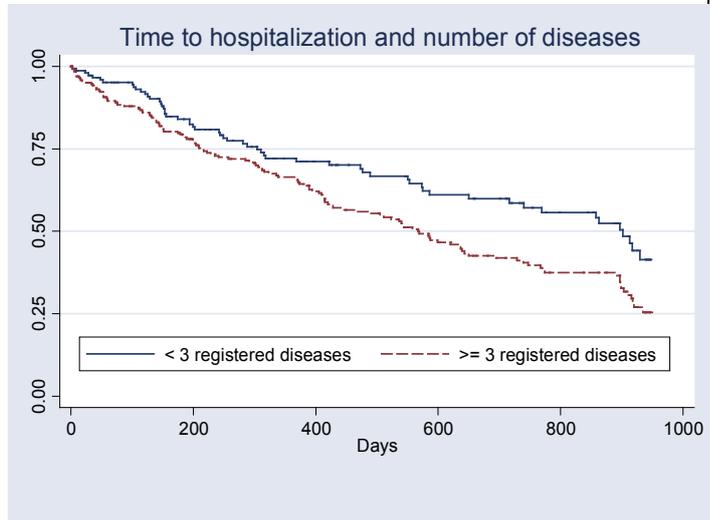
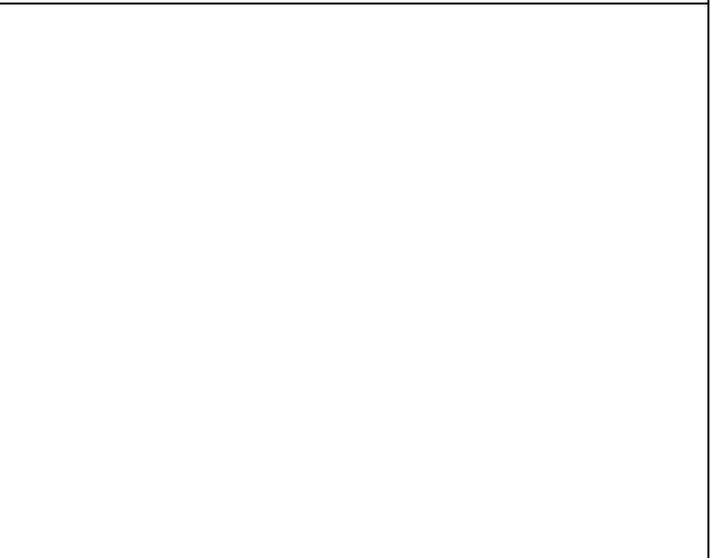
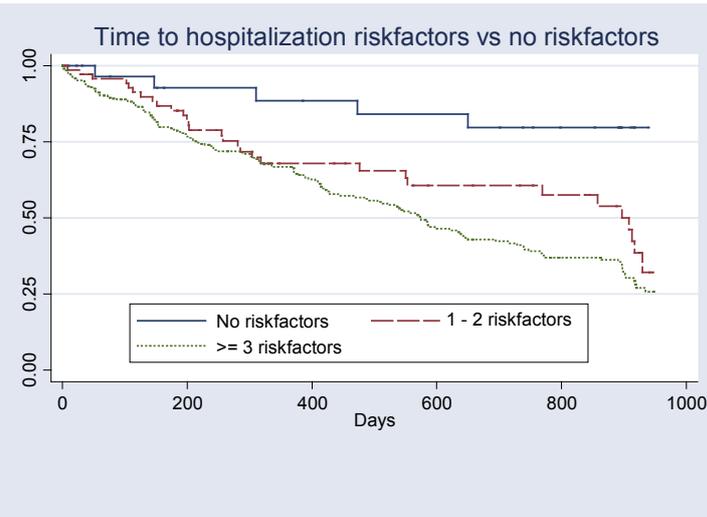


Figure 2e.



*Notes:* Number of drugs and number of diseases were dichotomized at the mean. Riskfactors in Figure 1e includes those risk factors that were significantly associated with increased risk of hospitalization in the multivariate analyses. Among 429 nursing home residents, 31 persons had no risk factor, 202 persons had one or two risk factors, and 196 persons had 3 or more risk factors.

**Table 1.** Baseline Characteristics and Comparisons and Cox Proportional Hazards Regression Bivariate Model of Time to Hospitalization

	Baseline			Cox Proportional Hazards Regression Bivariate Model				
	Total population Mean (SD) N=429	Hospitalized Mean (SD) n=196	Not Hospitalized Mean (SD) n=233	p-value	Total N	HR	95% CI for HR	p-value
Age	85.0 (6.9)	84.3 (6.9)	85.6 (6.9)	0.05	429	1.00	0.98-1.01	0.827
Male, <i>n</i> (%)	125 (29.1)	59 (30.1)	66 (28.3)	0.69	125	1.19	0.88-1.62	0.266
Health indicators								
Weight (kg)	66.8 (15.1)	67.2 (14.3)	66.5 (15.8)	0.64	426	1.04	0.96-1.13	0.305
Systolic blood pressure (mm/Hg)	135.5 (24.5)	137.1 (25.3)	134.2 (23.7)	0.23	405	1.00	0.88-1.13	0.964
Diastolic blood pressure (mm/Hg)	73.2 (12.3)	74.1 (12.0)	72.5 (12.5)	0.19	405	1.07	0.89-1.30	0.469
Pulse pressure	61.4 (20.0)	62.0 (20.4)	60.8 (19.5)	0.57	403	0.95	0.85-1.07	0.403
Number of diseases*	3.0 (1.3)	3.1 (1.3)	2.8 (1.4)	0.007	428	1.35	1.19-1.53	< 0.001
Number of drugs	6.8 (3.1)	7.3 (3.2)	6.4 (3.0)	0.003	420	1.38	1.21-1.59	< 0.001
No physical activity, <i>n</i> (%)	233 (54.3)	115 (48.7)	121 (51.3)	0.61	403	0.67	0.49-0.93	0.018
Previous falls	0.6 (0.5)	0.7 (0.5)	0.6 (0.5)	0.001	416	1.78	1.51-2.11	< 0.001
Need of care IADL	20.0 (0.2)	20.0 (0.0)	20.0 (0.3)	0.21	411	0.96	0.04-155.78	0.646
Need of care PADL	12.1 (5.9)	12.0 (5.9)	12.2 (6.0)	0.738	411	1.00	0.98-1.03	0.791
Risk assessment								
Risk of falling, DFRI	4.8 (1.6)	5.1 (1.6)	4.6 (1.6)	0.003	428	1.35	1.23-1.47	< 0.001
Risk of malnutrition MNA-SF, <i>n</i> (%)	189 (44.1)	81 (41.3)	108 (55.1)	0.79	424	1.20	0.87-1.64	0.266
Malnourished MNA-SF, <i>n</i> (%)	70 (16.3)	40 (20.4)	30 (15.3)	0.037	424	1.89	1.60-2.23	< 0.001
Risk of pressure ulcers MNS, <i>n</i> (%)	122 (28.4)	55 (28.2)	67 (29.1)	0.83	425	1.10	0.79-1.55	0.566
MMSE, <i>n</i> (%)	290 (67.6)	140 (71.4)	150 (64.4)	0.32	420	1.02	0.80-1.31	0.848
Cornell Depression Scale, <i>n</i> (%)	23 (5.4)	14 (7.1)	9 (3.9)	0.18	371	1.19	1.10-1.28	< 0.001
Organizational factors								
High registered nurse ratio, <i>n</i> (%)	176 (41.0)	84 (42.9)	92 (39.5)	0.74	419	0.85	0.68-1.06	0.148
High nursing assistant ratio, <i>n</i> (%)	201 (48.0)	97 (48.3)	104 (51.7)	0.56	419	0.82	0.64-1.05	0.120

Notes: \*Dementia (63.2%), Hypertension (43.6%), Stroke (22.1%), Atrial fibrillation (21.2%), Diabetes mellitus (19.1%), Congestive heart failure (17.7%). Cut-off scores: DFRI  $\geq 3$ , Risk of malnutrition MNA-SF 8-11, Malnourished MNA-SF  $\leq 7$ , Risk of pressure ulcers MNS  $\leq 20$ , Cornell Depression Scale CSDD  $> 8$ . In the Cox Proportional Hazards Regression Bivariate Model each variable is controlled for age, gender, and sites. Age and gender are controlled for each other. Continuous variables were standardized using z-transformation to allow for easier comparisons

**Table 2.** Multivariate Cox Proportional Hazards Regression Analyzing Time to Hospitalization

	Total N	HR	95% CI for HR	p-value
Age	429	1.00	0.99 – 1.02	0.902
Gender, male	125	1.10	0.78 – 1.55	0.599
No physical activity	403	0.85	0.65 – 1.11	0.236
Number of diseases	428	1.23	1.06 – 1.44	0.008
Numbers of drugs	420	1.20	1.03 – 1.40	0.018
Malnourished, MNA-SF	424	1.85	1.29 – 2.65	0.001
Previous falls	416	1.47	1.12 – 1.93	0.006
Cornell Depression Scale	371	1.08	0.98 – 1.20	0.125

*Notes:* Significant variables from the bivariate analyses are included in the regression.

Continuous variables were standardized using z-transformation to allow for easier comparisons.

Cut-off scores: Malnourished MNA-SF  $\leq 7$  and Cornell Depression Scale CSDD  $> 8$ .