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Factors associated with hospitalization risk among community living middle aged and older persons: results from the Swedish Adoption/Twin Study of Aging (SATSA)

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Abstract

The aims of the present study were to: (1) describe and compare individual characteristics of hospitalized and not hospitalized community living persons, and (2) to determine factors that are associated with hospitalization risk over time. We conducted a prospective study with a multifactorial approach based on the population-based longitudinal Swedish Adoption/Twin Study of Aging (SATSA). A total of 772 Swedes (mean age at baseline 69.7 years, range 46-103, 59.8% females) answered a postal questionnaire about physical and psychological health, personality and socioeconomic factors. During nine years of follow-up, information on hospitalizations and associated diagnoses were obtained from national registers. Results show that 484 persons (63%) had at least one hospital admission during the follow-up period. The most common causes of admission were cardiovascular diseases (25%) and tumors (22%). Cox proportional hazard regression models controlling for age, sex and dependency within twin pairs, showed that higher age (HR=1.02, p<0.001) and more support from relatives (HR=1.09, p=0.028) were associated with increased risk of hospitalization, while marital status (unmarried (HR=0.75, p=0.033) and widow/widower (HR=0.69, p<0.001)) and support from friends (HR=0.93, p=0.029) were associated with lower risk of hospitalization. Social factors were important for hospitalization risk even when medical factors were controlled for in the analyses. Number of diseases was not a risk in the final regression model. Hospitalization risk was also different for women and men and within different age groups. We believe that these results might be used in future interventions targeting health care utilization.

Highlights

- While medical factors are important when predicting hospitalization, social factors matter as well.

- Marital status significantly affects hospitalization risk.

- Hospitalization risk differs between community-living men and women.

- Different factors are associated with hospitalization risk in different age groups.

1. Introduction

Due to worldwide population aging and increasing life expectancy (Mathers, Stevens, Boerma, White, & Tobias, 2014), research on older persons' health has become an important issue (Vaupel, Zhang, & van Raalte, 2011). Many older persons require large amounts of healthcare resources. Therefore, research on healthcare utilization is important to track the health of the population and allocate resources optimally. Number of hospital admissions is one way to measure healthcare use, and studies on factors associated with hospital admissions will contribute information to unravel the underlying drivers of utilization.

In Sweden, between 1995 and 2010, the average time to first hospitalization after the age of 60 increased by 2 years (Karampampa, Drefahl, Andersson, Ahlbom, & Modig, 2013). There has also been an increase in the proportion of people who have never been hospitalized. Nevertheless, older persons are often hospitalized, although hospitalization itself may cause adverse health outcomes (Creditor, 1993; Ehlenbach et al., 2010; S. M. Friedman, Mendelson, Bingham, & McCann, 2008).

International research has shown that older age, low levels of physical performance (Dorr et al., 2006; Li, Chu, Sheu, & Huang, 2011), limitations in activities of daily living (Li, Chang, Wang, & Bai, 2011), comorbidity (Dorr et al., 2006; Landi et al., 2004), potentially inappropriate medications (Albert, Colombi, & Hanlon, 2010), and previous hospital admissions (Landi et al., 2004) are factors related to higher risk of hospitalization. In addition, hospitalization is related to community assistance (Nägga, Dong, Marcusson, Skoglund, & Wressle, 2012) and economic hardship (Landi et al., 2004) as well as psychosocial factors such as life satisfaction, loneliness (Jakobsson, Kristensson, Hallberg, & Midlöv, 2011), and self-rated health (Li, Chang, et al., 2011; Nägga et al., 2012). Moreover, personality traits, including higher neuroticism, have been associated with increased likelihood for visits to emergency departments (B. Friedman, Veazie, Chapman, Manning, & Duberstein, 2013). Further, older persons seem to have more trust in hospital care than in primary care and home health care (Fried, van Doorn, Tinetti, & Drickamer, 1998; Hallgren, Ernsth Bravell, Dahl Aslan, & Josephson, 2015), and this trust affects the propensity to seek hospital care.

Most previous studies only include a few factors and, to our knowledge, no study that focused on evaluating the risk of hospitalization specifically among community-dwelling older persons has included a wide variety of psychological, social and medical factors. To explore factors related to this risk, a prospective study with a multifactorial approach was conducted using data from the population-based longitudinal Swedish Adoption/Twin Study of Aging (SATSA). Andersen's health behavior model was used for classifying risk factors. The model

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(Andersen, 1968; Andersen, Davidson, & Baumeister, 2014) asserts that individuals' use of healthcare is a human behavior influenced by predisposing factors, enabling factors, and need for healthcare, as well as health behaviors, and has been used previously in healthcare utilization studies (B. Friedman et al., 2013; Nägga et al., 2012).

The specific objectives of this study were to: (1) describe and compare individual characteristics of hospitalized and not hospitalized community living persons, and (2) to determine factors that are associated with hospitalization risk over time.

2. Materials and methods

2.1 Sample

The participants in SATSA were same-sex twin pairs reared together and reared apart drawn from the Swedish Twin Registry (STR). The selection criteria have been described in detail previously (Finkel & Pedersen, 2004). In brief, the aim of SATSA, which started in 1984 when the first questionnaire (Q1) was sent out, was to study the etiology of individual differences in aging. Questionnaires included items and scales addressing self-rated health, loneliness, depression, personality, medications, social networks and housing situation.

The baseline of this study is the fifth questionnaire (Q5) wave in SATSA, where794 individuals participated. The rationale for using Q5 as baseline, instead of an earlier wave, is that at Q5 a sufficient number of persons had reached 65 years of age, the age of interest. Further, we also wanted to use data that reflect the current cohort of elderly and the current healthcare system. Since the aim of this study was to study hospitalization risk among community-living older persons, participants living in institutions were excluded (n=22). The study sample (N=772) was linked to registry data from the Swedish National Patient Register (NPR) with information on the participants' inpatient hospital admissions.

2.2 Measures

2.2.1 Predisposing characteristics

Predisposing factors are individual characteristics existing prior to illness that may affect need for or utilization of healthcare (Andersen et al., 2014). Variables included as predisposing characteristics in this study were age, marital status, level of education, locus of control, and personality traits. Education was dichotomized as upper secondary or university education (1)

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and compulsory or vocational education (0). Locus of control included three subscales: sense of personal control or lack of control over the direction of one's own life (Life Direction), beliefs about how responsible people are for misfortunes in their lives (Responsibility), and beliefs concerning the role of luck in determining people's outcomes (Luck) (N. Pedersen, Gatz, Plomin, Nesselroade, & McClearn, 1989). Personality traits included measures of neuroticism and extraversion from the EPI (N. L. Pedersen, Plomin, McClearn, & Friberg, 1988), EAS temperaments: activity, emotionality, sociability and fear (Buss & Plomin, 1984), impulsivity (Schalling, Åsberg, Edman, & Oreland, 1987), modified openness to experience (Bergeman et al., 1993), Type-A behavior hard driving (Lichtenstein, Pedersen, Plomin, de Faire, & McClearn, 1989) and paranoid hostility and cynicism (Costa, Zonderman, McCrae, & Williams Jr, 1986). Optimism and pessimism scales as modified by Plomin et al (1992) were also included.

2.2.2 Enabling characteristics

Enabling characteristics are factors that either hinder or facilitate use of a service once a need has been recognized (Andersen et al., 2014). Both objective and subjective socioeconomic status (SES) were included, as well as childhood SES (high score implies higher SES). We dichotomized whether a participant regularly (at least once a week) received help or was looked after by an immediate family member, relatives, social worker or health staff (1), or not (0). Social support was measured with three social support scales: friends' support, relatives' support and perceived support. Perceived support relates to whether one is satisfied with the number of friends, relatives and neighbors in one's life (Henderson, Duncan-Jones, Byrne, & Scott, 1980). Different life events were included, i.e. events that are not controllable, such as serious illness of self or relatives, death of relatives, and changes in economic situation or in social relationships. We included self-care events (e.g. somatic or mental illness, difficulty looking after oneself), controllable events (e.g. financial situation, changes in married life), uncontrollable events (e.g. serious illness, death or nursing home care of spouse) and undesirable events (e.g. loss of sexual ability), and the scales were created by summing the weighted importance of events that have occurred (Plomin, Lichtenstein, Pedersen, McClearn, & Nesselroade, 1990). Whether the participants were troubled by feelings of loneliness or not was dichotomized as always/often (1) versus never/seldom (0).

2.2.3 Need characteristics

Need characteristics are factors associated with health, disease and functional status. In this study, need factors involved both subjective and objective health aspects. Objective health was indexed as the number of up to 13 organ systems affected by disease. Subjective health was measured by life satisfaction (Harris et al. (1992), and by a combined self-rated health scale (general health now, health now versus 5 years ago, own health compared with that of others, activities limited by health). Mental health was measured using the Center for Epidemiologic Studies Depression Scale (CES-D) (Gatz, Johansson, Pedersen, Berg, & Reynolds, 1993). Incidence of falls in the past year was dichotomized as whether the participant had fallen and landed on the floor (1) versus not (0).

2.2.4 Health behaviors

Health behaviors are factors related to personal practices that influence health status. We measured the participants' smoking status (Nonsmoker, Ex-smoker or Current smoker), and level of physical activity was dichotomized as active (daily or once/a couple of times weekly) (1) or inactive (less than weekly) (0).

2.2.5 Outcome

Participants were followed from the baseline survey in 2003 to the first hospitalization after baseline, time of death, or the end of the follow-up in the study (31 Dec 2012). The first hospitalization was defined as a hospital admission that included an overnight stay. Information about hospitalization and the associated diagnoses came from the NPR. The main diagnosis was registered according to the World Health Organization's ICD-10 (International Classification of Diseases). Diagnoses were categorized into groups in accordance with the sections of the ICD-10. Sub analyses were also conducted on Ambulatory Care Sensitive Conditions (ACSC), often referred to as avoidable conditions, i.e., conditions seen as potentially avoidable with optimal primary care (National Board of Health and Welfare, 2014). Date of death was obtained from the NPR.

2.3 Statistical Analyses

The χ^2 test or t-test was used for comparisons between groups of individuals who had and had not been hospitalized during the follow-up period. To allow for easier comparisons, continuous variables were standardized using z-transformation, which renders a mean of 0 and a standard deviation of 1. All data were analyzed using StataIC 12.0.

Cox proportional hazards regression analyses were performed to evaluate factors associated with hospitalization risk. Number of days from baseline was used to calculate time to event, that is, the participant's first hospitalization after the baseline survey in 2003, to time of death, or to the end of the follow-up period (end of 2012). Left censoring was taken into account by using age in days as the time scale. A robust standard error estimator was used to adjust for the potential dependencies within twin pairs (Lin & Wei, 1989).

In the first model all participants were included and each factor was evaluated separately in relation to hospitalization risk, controlling for age and sex. Separate analyses were also conducted for men and women, and for different age groups: below 65, 65 to 80, and over 80 years.

In the next step, factors in the first model that were significantly associated with hospitalization risk among participants in all ages were simultaneously entered into the model. Again, separate analyses were conducted within the different age groups, and among men and women in their respective age groups. Lastly, analyses were conducted comparing participants with hospitalizations due to avoidable conditions versus conditions regarded as not avoidable.

3. Results

The mean age of the sample at baseline was 70 years (range 46-103 years; 60% female). During the follow-up period of nine years, 484 persons (63%) had been hospitalized at least once. Among those, 34% had been hospitalized once, 30% had been hospitalized two or three times, and 36% had been hospitalized more than three times. The most common primary diagnoses, for first hospitalization as well as all admissions, were cardiovascular diseases (25% and 22%, respectively) and tumors (22% and 15%, respectively) (Table 1). Of the first hospitalizations, 5% were regarded as avoidable admissions, representing conditions that could have been treated outside the hospital setting. For all admissions, 8% were avoidable. The most common diagnoses among all avoidable admissions were cardiovascular diseases (25%) and respiratory diseases (12%). Among the participants first avoidable admissions, the most common diagnoses for the first hospitalization were cardiovascular diseases (33%) and diseases of the urogenital tract (21%).

Table 2 describes the baseline characteristics and differences between those who were hospitalized during the study period and those who were not. Higher age, lower internal locus of control (specifically the subcategory "luck"), receipt of help, more self-care events, more undesirable events, higher number of illnesses, lower self-rated health and having experienced

a fall within the last 12 months were statistically significantly more common among subsequently hospitalized participants. Falls were more common among hospitalized women and receiving help on a regular basis was more common among hospitalized men.

Insert Tables 1 and 2 about here

Factors that were significantly associated (p<0.05) with hospitalization risk in the first Cox proportional hazards regression model for the whole population, controlling for age and sex, included predisposing characteristics (age and marital status), enabling characteristics (subjective SES, support from relatives and friends and self-care events), need characteristics (number of illnesses, self-rated health and falls in the last 12 months). Some gender differences were noted. Being a widow significantly decreased the risk for hospitalization among women, but there was no analogous effect for men. Divorced men had significantly higher risk for hospitalization than did married men, and higher subjective SES was associated with a decreased hospitalization risk among men. No such effects were seen among women (Supplementary Table 1).

There were also some age differences. Personality factors (higher neuroticism and being less active), lower life satisfaction, and receiving help on a regular basis were significantly related to increased hospitalization risk within the 65-to-80 age group. A greater number of illnesses increased hospitalization risk for both men and women and among the oldest participants. No factors related to health behaviors were significantly associated with hospitalization risk (Supplementary Table 1).

In model 2, factors significantly associated with hospitalization risk in the total sample from model 1 were entered simultaneously (Table 3). The results revealed that being older and male both increased hospitalization risk. Marital status, i.e., being a widow/widower or never married as opposed to being married/cohabiting, was associated with decreased hospitalization risk. Support from relatives was significantly associated with higher risk for hospitalization. Support from friends was associated with lower risk for hospitalization. Neither number of illnesses nor self-rated health was associated with hospitalization risk in the multivariate model. When men and women were analyzed separately, the effect of being unmarried was only significant for women, and higher subjective SES was associated with decreased hospitalization risk only among men. Decreased hospitalization risk for widows/widowers was only significant in the higher age groups, but the hazard ratio was similar to that of the younger age group. Support

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from friends was associated with lower risk for hospitalization, especially among the middle age group. Support from relatives was associated with higher risk for hospitalization.

Insert Table 3 about here

When comparing participants with avoidable hospitalizations to participants with other causes for hospitalization, the former were more likely to have a lower level of education and a more internal locus of control (specifically, the subcategory "luck"), to have received help on a regular basis, to have fallen in the last 12 months, and to be less physically active (Supplementary Table 2).

4. Discussion

This is to our knowledge the first study to evaluate the association of a wide range of psychological, social and medical factors with risk of hospitalization among community-living middle-aged and older persons. The results revealed that marital status, i.e., never having been married or being a widow/widower, and more support from friends were associated with lower risk of hospitalization, while greater age and more support from relatives were associated with increased risk of hospitalization. There were also gender and age differences in risk. Number of illnesses was not related to hospitalization risk in any age group or for either sex when other variables were included in the model.

Among the predisposing factors, never having been married or being a widow/widower was associated with a decreased risk of hospitalization. This is somewhat surprising since married persons, especially men, have been shown to have better emotional and physical health than unmarried persons (Coombs, 1991; Iloabuchi, Mi, Tu, & Counsell, 2014). Married persons even tend to live longer, have shorter hospital stays (Gordon & Rosenthal, 1995) and higher 90-day survival rates after hospital admission (Metersky, Fine, & Mortensen, 2012). One likely explanation for our finding is that spouses might encourage each other to seek hospital care. Another possible explanation is the selection of single living older persons into nursing homes and other institutions. Married and cohabiting persons continue to live in their own homes despite health problems that would lead to institutionalization among single persons.

Among enabling factors, we found that more support from friends was associated with decreased risk of hospitalization. This contributes to a body of research indicating that social

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relationships have health-promoting effects (House, Landis, & Umberson, 1988; Seeman, 2000) and decrease the risk of hospitalization (Laditka & Laditka, 2003). The unique aspect of our study is that we can show that this association is present even after controlling for health and health behaviors. Support from friends may be positive through not only providing support and information related to healthcare services, but also encouraging healthy behaviors and thus decreasing depression. In return, better health also makes it possible to maintain social relations. In contrast, we found that having more support from relatives increases the risk of being hospitalized. This seemingly contradictory finding may be explained by the fact that relatives watch over and encourage each other to seek hospital care, just as married and cohabiting couples do, and this tendency is likely to increase as health deteriorates. Our earlier finding that older home healthcare patients report that their relatives have an active part in the decision to seek hospital care (Hallgren, Ernsth Bravell, Dahl Aslan, et al., 2015) supports this conclusion.

We found that males, but not females, with lower subjective SES had an increased risk of hospitalization. Lower objective SES is associated with worse health (Shishehbor, Litaker, Pothier, & Lauer, 2006) and with hospital admissions among both genders (Lucchetti et al., 2009). However, there are also studies that support a stronger association of low subjective SES with health among men than among women (Hemingway et al., 2005). Despite varying results, there is more evidence for an increased association between various aspects of SES and hospitalization in men than women, and thus, SES should be evaluated when seeing patients, especially among men, in order to tailor appropriate care resources.

The most common diagnosis for first hospitalization and all subsequent admissions was cardiovascular disease, consistent with previous work based on community-dwelling older persons as well as nursing home residents (Goebeler, Jylhä, & Hervonen, 2004; Hallgren, Ernsth Bravell, Mölstad, et al., 2015). Thus, battling lifestyle factors that increase the risk of cardiovascular disease continues to be of great importance. Surprisingly, however, no factors associated with need (i.e., number of diseases or falls) were related to hospitalization when other factors are controlled for. However, number of illnesses and self-rated health correlated to an extent that might have affected the results.

Interestingly, none of the health behaviors analyzed, smoking status or physical activity, was related to hospitalization risk. It is likely that the negative effect of health behaviors is subsumed by other measures of health, e.g., number of diseases. It is also worth mentioning

that relatively few participants were smokers in this population. Attrition may have been higher for smokers, due to worse health status or mortality.

Finally, merely 5% of the participants' first admissions (and 8% of all admissions) were regarded as ambulatory care-sensitive conditions. This was surprising and encouraging, meaning that the majority of all admissions were regarded as necessary. We found that participants with avoidable hospitalizations (only 24 participants, 5% of the first hospitalizations and 8% of all hospitalizations) were more likely to have lower education, to regularly receive help, to have fallen with the past year, and to be less physically active. We found that higher internal locus of control was more prevalent among those with avoidable hospitalization. However, these results should be interpreted with caution given the small sample of such patients.

This study has a number of strengths, including the prospective follow-up design and the population-based sample. Another strength is that SATSA includes persons from across Sweden with a variety of medical conditions, providing good external validity of the findings within the Swedish context. Although this study had several advantages, there are limitations that should be noted. Risk factors included in the analyses were measured at baseline and do not take into account important events that may have occurred during follow-up. Further, differences in the results between age groups may represent cohort effects, where the likelihood of seeking healthcare may differ. A larger sample might have allowed further stratification within gender and age groups that could have revealed further gender differences. Finally, it was not possible to control for the proximity to hospital, which might have had an impact on the propensity to seek hospital care.

5. Conclusions

In summary, our findings indicate that social factors such as marital status and support from friends and relatives are important for predicting hospitalization risk. Number of diseases or falls was unrelated to hospitalization risk. These results suggest that a broad range of factors, not just medical factors, should be given attention to when assessing risk of hospitalization, and highlights the complexity of identifying risk factors among middle aged and older people. From a clinical standpoint these findings underscore the need for professionals in primary care as well as in home health care to consider the social environment of patients, and in particular to consider older persons lacking social support as this may affect healthcare utilization.

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Conflict of interest

None.

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Table 1

The participants´ primary diagnoses from their first hospitalization and primary diagnoses from all their hospitalizations.

	The participants' first hospitalization after the baseline survey in 2003			All hospitalizations from the baseline survey to 2012-12-31		
	Avoidable hospitalization f (%)		Total (%)	Avoidable hospitalization f (%)		Total (%)
	No	Yes		No	Yes	
Primary diagnose						
Cardiovascular diseases	112	8 (33.3)	120 (24.8)	372	35 (24.8)	407 (22.3)
Tumors	103	2 (8.3)	105 (21.7)	253	13 (9.2)	266 (14.6)
Muscle and joint diseases	42	0	42 (8.7)	122	4 (2.8)	126 (6.9)
Infections	40	2 (8.3)	42 (8.7)	55	2 (1.4)	57 (3.1)
Injuries, fractures	28	0	28 (5.8)	149	15 (10.6)	164 (9.0)
Gastrointestinal diseases	28	1 (4.2)	29 (6.0)	118	9 (6.4)	127 (7.0)
Diagnoses of symptoms	23	0	23 (4.8)	163	14 (9.9)	177 (9.7)
Diseases of the urogenital tract	15	5 (20.8)	20 (4.1)	88	16 (11.3)	104 (5.7)
Neurological diseases	19	1 (4.2)	20 (4.1)	39	1 (0.8)	40 (2.2)
Psychiatric disorders including dementia	14	0	14 (2.9)	57	1 (0.8)	58 (3.2)
Diseases of the respiratory tract including pneumonia	6	4 (16.7)	10 (2.1)	106	17 (12.1)	123 (6.7)
Endocrinological diseases	8	0	8 (1.7)	23	7 (5.0)	30 (1.6)
Diseases of the eyes, ears, nose and throat	7	1 (4.2)	8 (1.7)	18	1 (0.8)	19 (1.0)
Skin diseases	3	0	3 (0.6)	14	0	14 (0.8)
Others	11	0	11 (2.3)	106	6 (4.3)	112 (6.1)
Total	459	24	483[a]	1683	141	1824

[a]The main diagnosis from one participant is missing.

Table 2
Baseline characteristics and comparisons of hospitalized and not hospitalized participants.

	All				Male			Female		
Variables (range)	Total population N= 772	Hospitalized n=484	Not hospitalized n=288	p-value[b]	Hospitalized n=202	Not hospitalized n=108	p-value[b]	Hospitalized n=282	Not hospitalized n=180	p-value[b]
PREDISPOSING CHARCTERISTICS										
Age (45.6-102.7), mean (sd)	69.7 (11.1)	71.5 (10.7)	66.7 (11.2)	<0.001	70.7 (9.9)	66.8 (10.5)	0.001	72.1 (11.1)	66.8 (11.6)	<0.001
Sex (male), n (%)	310 (40.2)	202 (41.7)	108 (37.5)	0.256						
Marital status										
Never married, n (%)	66 (8.5)	32 (6.7)	34 (11.9)	0.016	16 (8.0)	17 (15.9)	0.033	16 (5.8)	17 (9.5)	0.125
Married/Cohabiting, n (%)	470 (60.9)	301 (63.1)	169 (59.1)	0.360	144 (71.6)	74 (69.2)	0.611	157 (56.9)	95 (53.7)	0.542
Widow/widower, n (%)	133 (17.2)	82 (17.2)	51 (17.8)	0.844	18 (9.0)	12 (11.2)	0.532	64 (23.2)	39 (21.8)	0.796
Divorced, n (%)	94 (12.2)	62 (13.0)	32 (11.2)	0.570	23 (11.4)	4 (3.7)	0.022	39 (14.1)	28 (15.6)	0.607
Education (Upper secondary/University vs Compulsory/Vocational), n (%)	143 (18.5)	80 (17.1)	63 (24.3)	0.020	41 (20.9)	28 (28.9)	0.145	39 (14.4)	35 (21.6)	0.065
Locus of control										
Life Direction (5-20), mean (sd)[a]	13.3 (2.7)	13.7 (2.6)	13.6 (2.7)	0.015	13.6 (2.6)	13.7 (2.4)	0.565	12.8 (2.6)	13.6 (2.8)	0.006
Responsibility (4-20), mean (sd)[a]	11.9 (3.2)	12.0 (3.2)	11.6 (3.1)	0.057	12.5 (3.1)	12.4 (3.2)	0.806	11.7 (3.2)	11. 1 (3.0)	0.040
Luck (3-15), mean (sd) [a]	9.0 (2.3)	8.8 (2.3)	9.3 (2.3)	<0.001	8.7 (2.2)	9.4 (2.4)	0.020	8.8 (2.3)	9.3 (2.3)	0.024
Personality										
Neuroticism (0-9), mean (sd)[a]	2.4 (2.1)	2.5 (2.1)	2.2 (2.1)	0.156	2.2 (2.1)	2.0 (2.1)	0.439	2.6 (2.1)	2.4 (2.2)	0.179
Extraversion (0-9), mean (sd)[a]	5.2 (2.3)	5.2 (2.2)	5.2 (2.4)	0.996	5.6 (2.1)	5.9 (2.2)	0.252	4.9 (2.2)	4.8 (2.4)	0.546
Active (1-5), mean (sd)[a]	2.8 (0.8)	2.8 (0.9)	2.9 (0.8)	0.059	2.8 (0.8)	3.0 (0.8)	0.052	2.8 (0.9)	2.9 (0.8)	0.339
Emotionality (1-5), man (sd)[a]	2.9 (0.7)	2.9 (0.7)	2.8 (0.6)	0.405	2.8 (0.7)	2.7 (0.6)	0.630	3.0 (0.7)	2.9 (0.6)	0.356
Sociability (1.3-5), mean (sd)[a]	3.7 (0.7)	3.7 (0.7)	3.7 (0.6)	0.119	3.7 (0.7)	3.8 (0.6)	0.183	3.7 (0.6)	3.7 (0.7)	0.358
Fear (1-4.8), mean (sd)[a]	2.3 (0.7)	2.3 (0.7)	2.3 (0.7)	0.819	2.1 (0.6)	2.1 (0.6)	0.948	2.5 (0.7)	2.4 (0.7)	0.503
Impulsivity (11-47.8), mean (sd)[a]	26.2 (5.7)	26.2 (5.9)	26.1 (5.5)	0.850	26.8 (6.1)	26.8 (6.1)	0.206	26.5 (5.9)	25.8 (5.1)	0.188
Openness (6-30), mean (sd)[a]	18.1 (4.2)	18.0 (4.2)	18.2 (4.3)	0.529	17.8 (4.1)	18.5 (4.3)	0.180	18.2 (4.2)	18.1 (4.3)	0.772
Hard driving (5-21), mean (sd)[a]	11.6 (3.2)	11.4 (3.1)	12.0 (3.2)	0.021	11.8 (3.0)	12.5 (3.0)	0.039	11.1 (3.2)	11.6 (3.3)	0.122
Paranoid Hostility (5-23), mean (sd) [a]	10.7 (3.5)	10.8 (3.5)	10.6 (3.5)	0.526	10.8 (3.6)	10.9 (3.4)	0.974	10.8 (3.4)	10.5 (3.6)	0.424
Cynicism (5-25), mean (sd) [a]	12.4 (3.8)	12.6 (3.8)	12.1 (3.7)	0.061	12.8 (3.8)	12.6 (3.5)	0.720	12.5 (3.8)	11.8 (3.8)	0.044
Optimism scale (6-20), mean (sd)[a]	14.9 (2.3)	14.8 (2.4)	14.9 (2.3)	0.562	14.8 (2.2)	15.0 (2.4)	0.425	14.8 (2.5)	14.9 (2.3)	0.899
Pessimism scale (4-20), mean (sd)[a]	9.8 (3.1)	9.9 (3.1)	9.5 (3.1)	0.035	9.8 (3.0)	9.3 (2.9)	0.107	10.0 (3.0)	9.6 (3.2)	0.143
ENABLING CHARACTERISTICS										
Socioeconomic situation										
SES during childhood (-7.3-17.1), mean (sd)[a]	0.7 (4.0)	0.5 (3.9)	1.1 (4.1)	0.086	0.6 (4.1)	1.1 (4.0)	0.317	0.5 (3.8)	1.0 (4.2)	0.158
Subjective SES (-11.3-7.9) (high score= high SES), mean (sd)[a]	0.1 (2.7)	-0.0 (2.8)	0.3 (2.6)	0.227	0.1 (2.8)	0.7 (2.1)	0.069	-0.1 (2.8)	-0.0 (2.8)	0.794
Objective SES (-11.3-7.9) (high score= high SES), mean (sd)[a]	0.7 (2.1)	0.6 (2.1)	0.9 (2.1)	0.116	0.9 (2.0)	0.8 (2.4)	0.917	0.5 (2.1)	0.9 (2.0)	0.026

Social network										
Regularly receive help or are looked after (Yes), n (%)	79 (10.2)	61 (12.7)	18 (6.2)	0.005	24 (11.9)	4 (3.7)	0.021	37 (13.2)	14 (7.8)	0.093
Support from relatives (-9.4-3.9), mean (sd)[a]	0.1 (3.1)	0.2 (3.0)	-0.3 (3.1)	0.032	-0.2 (3.3)	-0.7 (3.4)	0.196	0.6 (2.9)	0.0 (2.8)	0.051
Percieved support (12-30), mean (sd)[a]	23.2 (2.0)	23.3 (2.1)	23.2 (1.9)	0.751	23.2 (2.0)	23.0 (2.3)	0.356	23.3 (2.1)	23.3 (1.6)	0.751
Support from friends (-16.8-8.1), mean (sd)[a]	0.3 (5.5)	-0.1 (5.8)	0.9 (5.0)	0.015	0.4 (5.8)	1.4 (4.3)	0.111	-0.5 (5.8)	0.6 (5.3)	0.046
Life events										
Self-care events (0-10.6), mean (sd)[a]	1.3 (1.7)	1.4 (1.8)	1.0 (1.4)	<0.001	1.4 (1.7)	0.9 (1.3)	0.016	1.5 (1.8)	1.0 (1.5)	0.005
Controllable events (0-15.2), (sd)[a]	2.7 (3.0)	2.8 (3.1)	2.6 (2.9)	0.348	2.8 (3.0)	2.5 (2.9)	0.398	2.7 (3.1)	2.6 (2.9)	0.608
Uncontrollable events (0-22.4), mean (sd)[a]	3.7 (4.1)	3.9 (4.2)	3.3 (3.9)	0.081	3.1 (3.6)	2.6 (2.7)	0.272	4.5 (4.6)	3.8 (4.4)	0.107
Undesirable events (0-32.5), mean (sd)[a]	8.4 (6.2)	9.0 (6.3)	7.4 (5.9)	0.002	8.1 (6.0)	6.7 (4.8)	0.050	9.6 (6.5)	7.9 (6.4)	0.009
Troubled by feelings of loneliness (Yes), n (%)	95 (12.3)	66 (13.9)	29 (10.2)	0.142	18 (9.0)	10 (9.4)	0.890	48 (17.5)	19 (10.6)	0.044
NEED CHARACTERISTICS										
Number of illnesses (0-11), mean (sd)[a]	3.2 (2.2)	3.4 (2.3)	2.7 (2.0)	<0.001	3.1 (2.2)	2.3 (1.8)	0.002	3.7 (2.4)	3.0 (2.2)	0.002
Depressed Mood (0-50), mean (sd)[a]	12.3 (8.4)	12.8 (8.5)	11.6 (8.3)	0.071	11.8 (8.0)	10.6 (8.5)	0.224	13.4 (8.7)	12.3 (8.1)	0.140
Self-rated health (-9.1-5.2), mean (sd)[a]	-0.3 (3.1)	-0.6 (3.2)	0.3 (2.8)	<0.001	-0.3 (3.2)	0.5 (2.5)	0.017	-0.8 (3.1)	0.2 (2.9)	<0.001
Life satisfaction (19-63), mean (sd)[a]	45.0 (7.3)	44.8 (7.3)	45.3 (7.2)	0.387	45.7 (7.1)	46.4 (6.8)	0.444	44.2 (7.3)	44.7 (7.4)	0.494
Fall in the last 12 month (Yes), n (%)	124 (16.1)	93 (20.0)	31 (10.9)	<0.001	28 (14.4)	11 (10.2)	0.371	65 (24.1)	20 (11.3)	0.001
HEALTH BEHAVIOURS										
Smoking status										
Non smoker, n (%)	580 (75.1)	368 (80.2)	212 (76.8)	0.452	147 (76.2)	83 (79.0)	0.434	221 (83.1)	129 (75.4)	0.101
Ex smoker, n (%)	24 (3.1)	14 (3.1)	10 (3.6)	0.654	11 (5.7)	3 (2.9)	0.281	3 (1.1)	7 (4.1)	0.042
Current smoker, n (%)	131 (17.0)	77 (16.8)	54 (19.6)	0.309	35 (18.1)	19 (18.1)	0.953	42 (15.8)	35 (20.5)	0.201
Physically active (Yes), n (%)	149 (19.3)	81 (18.7)	68 (26.1)	0.028	37 (19.9)	30 (29.7)	0.079	44 (17.7)	38 (23.8)	0.164

[a]Based on scales.

[b]Comparisons between hospitalized and not hospitalized participants using χ^2 –test or t-test.

Table 3

Cox Proportional Hazards Regression Model of Time to Hospitalization controlled for age, sex and dependencies within twin pairs, all variables have been included simultaneously.

	All N=772		Male n=310		Female n=462		Age <65 n=273		65≤ Age <80 n=333		Age ≥80 n=166	
PREDISPOSING CHARCTERISTICS	**HR**	**p-value**	**HR**	**p-value**	**HR**	**p-value**	**HR**	**p-value**	**HR**	**p-value**	**HR**	**p-value**
Age	1.02	<0.001	1.02	0.001	1.02	<0.001	1.03	0.049	0.99	0.737	0.97	0.107
Sex (female)	0.89	0.050					0.82	0.155	0.90	0.206	0.94	0.443
(male)	1						1		1		1	
Marital status												
Never married	0.75	0.033	0.86	0.383	0.66	0.044	0.60	0.061	0.84	0.391	1.03	0.877
Married	1		1		1		1		1		1	
Widow/widower	0.69	<0.001	0.65	0.025	0.68	0.001	0.58	0.353	0.63	0.005	0.80	0.040
Divorced	0.99	0.898	1.28	0.054	0.88	0.349	1.11	0.501	0.91	0.531	0.86	0.434
ENABLING CHARACTERISTICS												
Subjective SES[a]	0.97	0.290	0.90	0.009	1.01	0.727	0.95	0.419	0.95	0.153	1.05	0.282
Support from relatives[a]	1.09	0.028	1.08	0.104	1.08	0.141	1.07	0.406	1.10	0.046	1.10	0.157
Support from friends[a]	0.93	0.029	0.94	0.241	0.93	0.071	0.93	0.375	0.87	0.001	1.02	0.724
Self-care events[a]	1.03	0.261	1.04	0.369	1.02	0.702	1.07	0.471	1.02	0.695	1.07	0.128
NEED CHARACTERISTICS												
Sum of illnesses[a]	1.05	0.146	1.06	0.470	1.06	0.193	1.02	0.831	1.04	0.383	1.06	0.315
Self-rated health[a]	0.95	0.092	0.95	0.217	0.94	0.187	1.01	0.892	0.88	0.009	0.95	0.270
Fall in the last 12 month (yes)	1.06	0.418	0.89	0.412	1.18	0.070	1.02	0.929	1.05	0.686	1.03	0.716
Fall in the last 12 month (no)	1		1		1		1		1		1	

[a]Linear representation.

Continues variables were standardized using Z-transformation