Predictors of Nursing Home Admission in the Older Population in Belgium

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Abstract

Background

This study examines the risk factors associated with nursing home admission (NHA) in Belgium to contribute to a better planning of the future demand for nursing home (NH) services and health care resources.

Methods

Individual level linkage of the 2013 Belgian health interview survey data and health insurance data (2012 to 2018) was done. Only non-institutionalized participants, aged ≥ 65 years at the time of the survey were included in this study ($n=1930$). Participants were followed until NHA, death or end of study period, i.e., December 31, 2018. The risk of NHA was calculated using a competing risk analysis.

Results

Over the follow-up period (median 5.29 years), 226 individuals were admitted to a NH and 268 died without admission to a NH. The overall cumulative risk of NHA was 1.4%, 5.7% and 13.1% at, respectively 1 year, 3 years and the end of follow-up. After multivariable adjustment, higher age, low educational attainment, belonging to low income household, living alone, use of home care services and a number of need factor (e.g., history of falls, suffering from urinary incontinence, depression or Alzheimer disease, etc.) were significantly associated with a higher risk of NHA, while female, individuals with multimorbidity and increased contacts with health care providers were significantly associated with a decreased risk of NHA. Subjective health and limitations are both significant determinants of NHA, but subjective health is an effect modifier on the effect of limitations and vice versa.

Conclusions

Our findings pinpoint important predictors of NHA in older adults, and offer possibilities of prevention to avoid or delay NHA for this population. The strong impact of need factors on the risk of NHA may indicate equitable access to NHA (i.e., those in need for support have access to NH). Practical implications include prevention of falls and appropriate and timely management of physical chronic conditions and neurodegenerative disorders. Focus should also be on people living alone to provide the appropriate social support and/or home care services. Further investigation of predictors of NHA should include contextual factors such as the availability of nursing-home beds, hospital beds, physicians and waiting lists for NHA.

Background

The ageing of populations combined with the increase in the prevalence of chronic conditions and the rapid advance in medical technology may lead to an increase of long-term care (LTC) services for older people [1]. In most industrialized countries, the demand for nursing homes (NH) is expected to rise

sharply during the coming years [1–4]. According to the demographic projections of the Belgian Federal Planning Bureau in 2019, the share of the population aged 67 and over, which was 16% in 2018, will rise to 20% in 2030 and 23% in 2070 [5]. Therefore, the number of people requiring care either at home or at nursing home (NH) will increase. If health policies focus on healthy ageing and the organization of well-functioning and integrated home care, the need for more NH may not be high. However, although living independently within the community is a major objective defining healthy ageing [6] the organization of LTC has to reflect on the balance between community and institutional care which both have a financial cost and a societal impact [6–8]. For a better planning of the future demand for NH services and health care resources, policy makers need to be aware of the risk factors associated with nursing home admission (NHA).

Previous studies have identified potential predictors of NHA on the basis of Andersen’s behavioral model of health services use, which considers the use of health services to be a function of an individual’s predisposing, enabling, and need characteristics [2, 3, 9–12]. Predisposing factors include demographics, social structure, and health beliefs. Enabling factors are those influencing an individual’s ability to gain access to health services and they include family and community resources. Need factors refer to the functional and health problems that generate the need for health care services [9]. The most relevant are marital status (being single or widowed), higher severity of cognitive impairment and mobility impairment [1], dementia [13, 14], living arrangement, older age [2, 7, 9, 15–17]. The role of urinary incontinence as predictor of NHA remains controversial. In seven NH studied, Ouslander et al. [18] found that 50% of the residents had urine incontinence and most had been incontinent at admission (64%). Another study found that urinary incontinence was a predictor of NHA in two cohorts of patients within the Kaiser Foundation Health Plan of Northern California [19], while Jayna M. Holroyd-Ledu et al. found that urinary incontinence was not an independent predictor of NHA after adjusting for confounders [20]. The causal relationship between urinary incontinence and NHA is thus issue for debate. However, higher levels of baseline illness severity and functional impairment appear to mediate this relationship [20].

An important limitation of most previous studies on this topic is the lack of generalizability of the results because they are often conducted among specific subgroups such as patients with dementia or Alzheimer [1, 13, 14, 21], myocardial infarction [16], or surgery as a result of a hip fracture [22]. Moreover, some of these studies lack power and precision since they are based on a small sample [7]. A major methodological shortcoming in some studies is that they fail to take into account death as a competing risk of NHA in the analysis, which may bias the results [1, 9, 15, 23].

Competing risks occur frequently in the analysis of survival data [24]. A competing risk is an event whose occurrence precludes the occurrence of the primary event of interest [24–27]. Competing risks may be encountered in large set of epidemiological studies. For example, in a study where interest focuses on a specific non-terminal event type such as dialysis onset, death before dialysis onset constitutes a competing risk [26]. In another study examining time to death attributable to cardiovascular causes, death attributable to non-cardiovascular causes is a competing risk, because subjects who die from another cause are no longer at risk of death due to cardiovascular causes [24, 25, 28]. Furthermore, in a

study of time-to-nursing home admission, death before NHA may influence NHA and therefore death is a competing risk as it precludes NHA [29].

In studies involving older individuals, competing risk of death is especially high due to the higher mortality in older people. Therefore, there is a concern to account for participants who die without experiencing the study outcome of interest. Traditional approaches in survival analysis include Kaplan-Meier survival analysis and cause specific survival analysis such as Cox proportional hazards regression; however, these methods are not designed to take into account the competing risk of death [30] and will result in an overestimation of the effect [24, 30]. The main assumption of the Kaplan-Meier method for instance is that any subject whose survival time is censored will experience the event of interest if followed up long enough. This does not hold if competing risks are present, as the occurrence of the event of interest is precluded or its probability of occurrence is modified by an antecedent competing event. In our study of NHA, many participants will die without being admitted to NH, and others may end the study without being admitted into a NH. Using a Kaplan-Meier approach, both the individuals who died and those who followed up until the study completion will be censored. Censored subjects will be considered “at risk” for the duration of the study, yet deceased persons cannot possibly be at future risk for NHA. By failing to account for the competing risk of death, both Kaplan-Meier and Cox model estimates will overestimate the incidence of NHA. The higher the death rate among the study population, the substantial the overestimation.

To account for the presence of competing risks, the proportional subdistribution hazards model was proposed by Fine and Gray [31]. In the proportional subdistribution hazards model, estimates are based on modified hazards sets, where subjects experiencing the competing event are retained even after their competing event [26], unlike the Cox model. Whereas the cause-specific hazard function of the Cox model for an event of interest is the instantaneous rate of occurrence of that event in subjects who are currently event-free, the Fine and Gray subdistribution hazard function for a given event is the instantaneous rate of occurrence of that event in subjects who are either currently event-free or who have already experienced a concurrent event [24, 28].

In studies of older individuals in which a substantial number of participants die during a long follow-up, the competing risk analysis should be used to accurately determine incidence and effect estimates [29, 30]. The objective of this study is to identify predictors of NHA among a representative sample of Belgian non-institutionalized population aged 65 years and over, considering death as competing risk factor.

Methods

Study population and data

The data for this study were derived from a linkage at the individual level between data from the Belgian health interview survey (BHIS) of 2013 and data from the Belgian compulsory health insurance (BCHI)

between 2012 and 2018. The linkage of both data sources is further referred as to HISlink. The study population is limited to those aged 65 years and older.

The BHIS is a national, cross-sectional household survey conducted more or less every 5 years since 1997 by Sciensano, the Belgian institute for health. Participants are selected from the national population register through a multistage stratified sampling procedure. The participation rate was 57% at household level for the BHIS 2013. In the BHIS, information is collected on the health status, health behavior, health care consumption, use of medicines and sociodemographic characteristics. Through the use of post stratification weights representative results are obtained at the level of the Belgian population. The detailed methodology of the survey is described elsewhere [32].

The BCHI data contain exhaustive and detailed information on the reimbursed health care of over 99% of the total population. These data were provided by the InterMutualistic Agency (IMA), a joint venture of the seven national sickness funds and collects and manages all data on healthcare expenditures. The BCHI contains three kinds of data: population data (a limited amount of demographic and socio-economic information), health care expenditure data (information on reimbursed health care) and pharmanet data (detailed information on all prescription issued in public pharmacies of reimbursed drugs) [33].

Individual BHIS 2013 data were linked with BCHI data using the unique national register number. The linkage rate was 96% for individuals aged 65 years and over. The BHIS sample includes both community dwelling and institutionalized people but for this study we only considered people aged 65 years and more residing at home at the moment of the interview (n = 1930).

Measures

Dependent variable

The main outcome was defined as a NHA after participating to the BHIS 2013 at any time during the follow-up period. The BHIS 2013 participants were followed until the date of NHA, the date of death or the end of study period, i.e., December 31, 2018. The information on the date of death was retrieved from the BCHI data. NHA was ascertained if at least one specific nomenclature code defined by the National Institute for Health and Disability Insurance (NIHDI) for reimbursement purpose and corresponding to care delivery into home for older people or nursing home was found. The date of the first care delivery into NH was considered to be the date of admission into the NH. Only the first admission into NH was considered in this study. Short-stay care episodes (defined by specific nomenclature codes) were excluded from the analyses.

Independent variables

Independent variables were classified according to Andersen's behavioral model of health care use, as

1) predisposing variables: age, gender, educational attainment

Educational attainment was based on the highest level of education achieved according to the ISCED 1997 [34] and recoded into three categories: low (lower secondary education or less), intermediate (higher secondary education), and high (higher education);

2) enabling factors: household income, living situations, appreciation of social contacts, home care services use, level of urbanisation, region of residence

For the household income level, the equivalised household income quintiles were recorded in low (quintile 1-3) and high (quintile 4 and 5);

3) need factors: subjective health, long term participation restrictions (GALI, Global Activity Limitations Indicator), multimorbidity, falls, urinary incontinence or problems in controlling the bladder in the past 12 months (either having had a package for incontinence in BCHI data or self-reported), depression (self-reported depression in the past 12 months or self-reported use of anti-depressants in the past 2 weeks), Alzheimer's disease, number of contacts with health care providers in the past 12 months preceding the survey (general practitioners, specialists, dentists, physiotherapists) and hospitalisation in the past 12 months preceding the survey.

Multimorbidity was defined as having suffered in the past year from at least two of the following diseases: serious heart disease, hypertension, obstructive lung disease, cancer, arthrosis or arthritis and diabetes [35]. The GALI is an indicator of limitations due to health problems taking into account the person's environment and support. It is based on a single question asking the respondent to estimate the possible restrictions due to their health: "Have you been limited for at least 6 months because of a health problem in the activities that people usually do" (Yes, severely limited / Yes, limited / No, not limited at all) [36]. Information on contact with health care providers, hospitalization, and Alzheimer's disease were obtained from the BCHI source. Urinary incontinence is a combined indicator from BCHI source (package of urinary incontinence) and BHIS (self-reported urinary incontinence in the past 12 months), while the other predictors were based on self-reported information. Alzheimer's disease cases were ascertained using an algorithm previously defined by a group of experts for the NIHDI. The algorithm is based on the anatomical, therapeutic, chemical (ATC) codes of specific drugs (N06DX01, N06DA) prescribed and dispensed in public pharmacies. The minimum threshold of 90 DDD (Defined Daily Dose) per year is used to determine cases [37].

Table 1 provides an overview of the independent variables.(levels of variables, data sources and proportion of missing values if any before the multiple imputation).

Table 1

Overview of the covariates, according to the risk factor groups and data sources, HISlink 2013, Belgium

Covariates	Level of covariates	Data sources		Missing values*
		BHIS	BCHI	n (%)
Predisposing				
Age		x		-
Gender	Male	x		-
	Female			
Education	Low	x		19 (0.98)
	Middle			
	High			
Enabling				
Household income	Low	x		280 (14.5)
	High			
Level of urbanization	Urban	x		-
	Sub-urban			
	Rural			
Region of residence	Flanders	x		-
	Brussels			
	Wallonia			
Living situations	Live alone	x		-
	Not live alone			
Appreciation of social contacts	Rather unsatisfied	x		440 (22.8)
	Rather satisfied			

*HISlink = linkage between BHIS 2013 data and BCHI data from 2012 to 2018; * Missing values before the multiple imputation; GALI = Global Activity Limitation Indicator;;^a Anatomical Therapeutic Chemical (ATC) classification codes used for cases identification: N06DX01, N06DA.*

Covariates	Level of covariates	Data sources	Missing values* n (%)
Home care service use in the past 12 months preceding the survey	Yes No	x	3 (0.16)
Need			
Subjective health	Good to very good Very bad to fair	x	426 (22.1)
Multimorbidity	Yes No	x	8 (0.41)
Long term limitation (GALI)	Yes, severely Yes No	x	452 (23.4)
Falls	Yes No	x	114 (5.91)
Urinary incontinence	Yes No	x x	5 (0.26)
Depression	Yes No	x	8 (0.41)
Alzheimer s' disease ^a	Yes No	x	-
Number of contact with care providers in the past 12 months		x	-
Hospitalization in the past 12 months preceding the survey	Yes No	x	-
<i>HISlink = linkage between BHIS 2013 data and BCHI data from 2012 to 2018; * Missing values before the multiple imputation; GALI = Global Activity Limitation Indicator;;^a Anatomical Therapeutic Chemical (ATC) classification codes used for cases identification: N06DX01, N06DA.</i>			

Statistical analyses

Descriptive statistics

Baseline characteristics described above were compared by NHA status (admitted to NH or not admitted to NH) with χ^2 test for categorical variables and t-test for continuous variables.

Participants were followed until the occurrence of NHA, death, or study completion. Time to NHA was measured in years from the baseline survey to either the date of admission to a NH, date of death (without prior NHA) or end of study period, i.e., December 31, 2018 [17]. Participants who ended their follow-up period were censored [38]. The median follow-up time and median time to NHA and their interquartile range (IQR) were calculated.

Competing risk analysis

In the current study, a competing risk regression model was used to estimate the association between predictors and admission to a NH, treating death during follow-up as a competing risk.

Cumulative incidence function was used to estimate the risk of the NHA over time (using Gray's method with death as a competing risk [29, 39–41]). The cumulative incidence function was estimated for the whole group and stratified by GALI with the Cuminc R-function [42]. Gray's test was used to examine for differences between the strata [29, 43].

In addition, we calculated sub-hazard ratios (sHR) of participants characteristics for risk of NHA, with death as a competing risk using the Fine and Gray's proportional sub-hazard model [26, 29, 31, 38, 39, 43].

We imputed missing variables using the fully conditional specification method. The proportion of missing values ranged from 0.16–23% (Table 1). As all the variables with missing values are either binary or ordinary, logistic regression method was used to imputed missing values [38, 44]. We created 20 imputed data sets. This number was enough to achieve a very good efficiency (the relative efficiency was close to 1.0 for all effects). Covariates which were significantly ($P < 0.05$) associated in the univariate analysis (results not shown) were retained in the final multivariable model [29]. Several interactions were tested between limitations (based on the GALI) and the other risk factors (age, gender, subjective health and multimorbidity) to account for the possibility that the effects of limitations on the risk of NHA may depend on the level of other risk factors. The interaction between limitations and subjective health was found to be statistically significant and interaction terms were therefore added in the final model. The HAZARDRATIO statement was used in PROC PHREG to produce custom hazard ratios for interactions [45].

In sensitivity analyses, we repeated the analysis with Cox proportional model and in non-imputed data sets (complete case analysis, $n = 1209$). In the Cox proportional model, participants who died without first admitted into NH and those who ended the study were censored.

The assumption of proportional subdistribution hazards was evaluated by including interaction terms between covariates and time [26, 39]. The assumption was found to be met for all the covariates.

All statistical tests were 2-tailed and we used $p < 0.05$ to determine statistical significance. Analyses were performed using SAS 9.4 taking into account for the complex BHIS design. For calculation of cumulative incidence function curves we used the package *cmprsk* by Gray [46] of the R project (R version 3.5.2 (2018-12-20)).

Ethics statement

This study was carried out through an individual linkage between the BHIS 2013 data and the BCHI data. The BHIS 2013 was carried out in line with the Belgian privacy legislation. The BHIS 2013 has been approved by the ethics committee of the University hospital of Ghent on October, 1st 2012 (advice EC UZG 2012/658). The participation to the BHIS is voluntary. There was no formal written and signed consent foreseen. Participation was equivalent to giving consent. The selected households were notified about the survey, its practical organization, the institution in charge, the commissioners of the survey and its content via a letter and an information leaflet personally addressed to them. It was also clearly stipulated in the letter and the leaflet that participation is voluntary. All data were fully anonymized before their access. In addition, data linkage was authorized by the Information Security Committee (local reference: Deliberation No. 17/119 of December 19, 2017, amended on September 3, 2019).

Results

Sample characteristics

The median follow-up time was 5.29 years (95% CI, 5.24-5.32), interquartile range (IQR), 5.12-5.59 years. At the end of follow-up, 226 individuals (13.3%) were admitted to NH with a median time to NH of 3.0 years, IQR: 1.5-4.6 and 268 individuals (13.2%) had died before having been admitted to a NH. Compared to those not admitted to a NH, participants who had been admitted to a NH were at baseline older, female, lower educated, belonged more often to a lower income household. They also lived more often alone, were rather unsatisfied with their social contact, had more often experienced falls in the year prior to survey, and suffered more often from health problems (bad subjective health, multimorbidity, limitations, urinary incontinence, cognitive disorders (depression or Alzheimer's disease)). Further information on participants characteristics can be found in Table 2.

Table 2
Baseline characteristics of the study population (n= 1930), HISlink 2013, Belgium (weighted %)

	Admitted to nursing home N = 226 (13.3%)	Not admitted to nursing home N = 1704 (86.7%)	P- value
Age, mean (SD)	80.1 (0.59)	73.9 (0.26)	<i><.0001</i>
Gender, n (%)			<i>0.0192</i>
Male	106 (45.8)	992 (57.6)	
Female	120 (54.2)	712 (42.4)	
Education, n (%)			<i>< 0.0001</i>
Low	144 (68.7)	713 (43.4)	
Middle	46 (17.1)	463 (28.8)	
High	36 (14.2)	528 (27.8)	
Household income, n(%)			<i>< 0.0001</i>
Low	181 (82.7)	1107 (66.3)	
High	45 (17.3)	597 (33.7)	
Level of urbanization, n (%)			<i>0.5857</i>
Urban	96 (36.9)	823 (42.4)	
Sub-urban	60 (34.2)	405 (30.6)	
Rural	70 (29.0)	476 (27.0)	
Region of residence, n (%)			<i>0.3470</i>
Flanders	83 (62.8)	630 (60.7)	
Brussels	37 (5.0)	363 (8.1)	
Wallonia	106 (32.1)	711 (31.2)	
Living situations, n (%)			<i><.0001</i>
Live alone	130 (51.9)	496 (29.0)	
Not live alone	96 (48.1)	1208 (71.0)	

HISlinkk = linkage between BHIS 2013 data and BCHI data from 2012 to 2018; ^a Anatomical Therapeutic Chemical (ATC) classification codes used for cases identification: N06DX01, N06DA.; GALI = Global Activity Limitation Indicator

	Admitted to nursing home N = 226 (13.3%)	Not admitted to nursing home N = 1704 (86.7%)	P- value
Appreciation of social contacts, n (%)			0.0185
Rather unsatisfied	33 (14.3)	134 (8.4)	
Rather satisfied	193 (85.7)	1570 (91.6)	
Home care service use in the past 12 months preceding the survey, n (%)			<.0001
Yes	102 (45.3)	346 (19.6)	
No	124 (54.7)	1358 (80.4)	
Subjective health, n (%)			0.0015
Good to very good	111 (50.7)	1117 (67.3)	
Very bad to fair	115 (49.3)	587 (32.7)	
Multimorbidity, n (%)			<.0001
Yes	93 (41.3)	559 (33.9)	
No	133 (58.7)	1145 (66.1)	
Long term limitation (GALI), n (%)			0.0041
Yes, severely	39 (15.9)	155 (9.9)	
Yes	87 (31.8)	484 (25.5)	
No	100 (52.3)	1065 (64.6)	
Falls, n (%)			<.0001
Yes	79 (36.2)	287 (17.0)	
No	147 (63.8)	1417 (83.0)	
Urinary incontinence, n (%)			<.0001
Yes	49 (22.8)	176 (10.7)	
No	177 (77.2)	1528 (89.3)	
Depression, n (%)			<.0001
Yes	50 (24.7)	195 (12.1)	

HISlinkk = linkage between BHIS 2013 data and BCHI data from 2012 to 2018; ^a Anatomical Therapeutic Chemical (ATC) classification codes used for cases identification: N06DX01, N06DA.; GALI = Global Activity Limitation Indicator

	Admitted to nursing home N = 226 (13.3%)	Not admitted to nursing home N = 1704 (86.7%)	P- value
No	176 (75.3)	1509 (87.9)	
Alzheimer disease ^a , n (%)			<.0001
Yes	9 (8.6)	20 (1.0)	
No	217 (91.4)	1684 (99.0)	
Number of contact with care providers in the past 12 months, mean (SD)	19.42 (1.91)	16.86 (0.71)	0.2078
Hospitalization in the past 12 months preceding the survey, n (%)			0.0380
Yes	59 (28.19)	323 (19.44)	
No	167 (71.81)	1381 (80.56)	
<i>HISlinkk = linkage between BHIS 2013 data and BCHI data from 2012 to 2018; ^a Anatomical Therapeutic Chemical (ATC) classification codes used for cases identification: N06DX01, N06DA.; GALI = Global Activity Limitation Indicator</i>			

Cumulative risk of nursing home admission

The overall crude cumulative risk of NHA was 1.4% (95% CI, 0.9-2.1) at 1 year of follow-up, 5.7% (95% CI, 4.7-6.8) at 3 years of follow-up and 13.1% (95% CI, 11.3-15.0) at the end of follow-up (5.9 years). Figure 1 provides the unadjusted cumulative incidence curves for NHA, stratified by GALI, with death as competing risk. The crude risk of NHA is significantly different in function of the severity of limitations (GALI) at least in one category as compared to the other categories (Gray's test: $\chi^2=22.28$, $p<0.0001$). Individuals who were severely limited have a higher risk of NHA at any time point of follow-up than those who were not. For instance, at the end of the study, the risk of NHA was significantly higher among individuals with severe limitations (20.0% (95% CI, 12.7-28.5)) than those without limitations (8.0% (95% CI, 6.2-10.1)). Whereas the risk of NHA was not statistically different between individuals with severe limitations (20.0% (95% CI, 12.7-28.5)) as compared to those with moderate limitations (16.2% (95% CI, 11.6-21.5)), (Figure 1).

Results of the subdistribution hazard model for nursing home admission

The results of the multivariable competing risk analysis are displayed in Table 3.

Table 3

Predictors for nursing home admission. Results from the competing risk regression (N=1930), HISlink 2013, Belgium

Potential risk factors	sHR (95% CI)
Predisposing	
Age	1.10 (1.09-1.11)**
Female	0.75 (0.72-0.78)**
Educational attainment (Ref. = High)	
Low	1.36 (1.25-1.48)**
Middle	0.82 (0.74-0.90)*
Enabling	
Low household income	1.29 (1.12-1.49)*
Living alone	1.75 (1.67-1.84)**
Unsatisfied with the social contacts	1.33 (0.93-1.91)
Home care service use in the past 12 months preceding the survey (Ref. =No)	1.53 (1.46-1.60)**
Need	
Long term limitation (GALI) and subjective health interaction ^a	
Bad subjective health vs. good subjective health at severe limitations	0.31 (0.30-0.32)*
Bad subjective health vs. good subjective health at moderate limitations	1.02 (1.00-1.03)
Bad subjective health vs. good subjective health at no limitations	1.75 (1.72-1.78)*

*HISlink = linkage between BHIS 2013 data and BCHI data from 2012 to 2018;^a The HAZARDRATIO statement was used in PROC PHREG to produce custom hazard ratios for interactions;^b ATC-codes used for cases identification: N06DX01; N06DA ; NHA = nursing home admission; sHR = sub Hazard Ratios; GALI = Global Activity Limitation Indicator. To facilitate reading, the GALI categories were reported as severe limitations, moderate limitations and no limitations, which referred to the categories yes, severely limited, yes limited and no, not limitation at all respectively; * $p < 0.05$; ** $p < 0.0001$.*

Potential risk factors	sHR (95% CI)
Severe limitations vs. no limitations at good subjective health	2.28 (2.21-2.35)*
Severe limitations vs. no limitations at bad subjective health	0.41 (0.40-0.42)*
Severe limitations vs. moderate limitations at good subjective health	2.11 (2.01-2.18)*
Severe limitations vs. moderate limitations at bad subjective health	0.64 (0.63-0.65)*
Moderate limitations vs. no limitations at good subjective health	1.10 (1.09-1.12)*
Moderate limitations vs. no limitations at bad subjective health	0.64 (0.63-0.66)*
Multimorbidity (Ref. = No)	0.92 (0.87-0.97)*
Falls (Ref. = No)	1.67 (1.58-1.77)**
Urinary incontinence (Ref. = No)	1.55 (1.32-1.83)**
Depression (Ref. = No)	1.33 (1.24-1.42)**
Alzheimer disease (Ref. = No) ^b	4.86 (4.48-5.27)**
Number of contact with health care providers in the past 12 months preceding the survey	0.98 (0.97-0.99)**
Hospitalization in the past 12 months preceding the survey (Ref. = No)	1.08 (1.01-1.16)*
<i>HISlink = linkage between BHIS 2013 data and BCHI data from 2012 to 2018;^a The HAZARDRATIO statement was used in PROC PHREG to produce custom hazard ratios for interactions;^b ATC-codes used for cases identification: N06DX01; N06DA ; NHA = nursing home admission; sHR = sub Hazard Ratios; GALI = Global Activity Limitation Indicator. To facilitate reading, the GALI categories were reported as severe limitations, moderate limitations and no limitations, which referred to the categories yes, severely limited, yes limited and no, not limitation at all respectively; * $p < 0.05$; ** $p < 0.0001$.</i>	

Among the predisposing factors, a one year increase in age is associated with a 10% increase risk of NHA, individuals with lower educational attainment have also a higher risk of NHA (sHR=1.36, 95% CI, 1.25-1.48) as compared to those with higher educational attainment, while being female, having an intermediate educational attainment were associated with a 25% and 18% reduction in the risk of NHA respectively.

Regarding the enabling factors, belonging to a low income household (sHR=1.29, 95% CI, 1.12-1.49), living alone (sHR=1.75, 95% CI, 1.67-1.84), use of home care services in the past 12 months (sHR=1.53, 95% CI, 1.46-1.60) were associated with a higher risk of NHA.

With respect to the need factors, as there is an interaction between subjective health and limitations, the interpretation of the sHRs of subjective health must take into account the levels of limitations and vice versa. Our results show that for the impact of limitations, 1) if people are in good subjective health: severe limitations (sHR=2.28, 95% CI, 2.21-2.35), and to a lesser extent moderate limitations (sHR=1.10, 95% CI, 1.09-1.12) increase the risk on NHA; 2) If people are in bad subjective health: moderate (sHR=0.64, 95% CI, 1.63-0.66) and severe limitations (sHR=0.41, 95% CI, 0.40-0.42) decrease the risk of NHA. For the impact of subjective health, 1) if people have no limitations: bad subjective health increases the risk of NHA substantially (sHR=1.75, 95% CI, 1.72-1.78); 2) if people have moderate limitations: bad subjective health increases the risk of NHA marginally (sHR=1.02, 95% CI, 1.00-1.03) and 3) if people have severe limitations: bad subjective health decreases the risk of NHA (sHR=0.31, 95% CI, 0.30-0.32).

Individuals experienced falls in the past 12 months (sHR=1.67, 95% CI, 1.58-1.77), those suffering from urinary incontinence (sHR=1.55, 95% CI, 1.32-1.83), those suffering from depression (sHR=1.33, 95% CI, 1.24-1.42) had higher risk of NHA than their counterparts, while those with multimorbidity had 8% less risk of NHA (sHR=0.92, 95% CI, 0.87-0.97). An increased number of contacts with health care providers was associated with a decreased risk of NHA. Individuals who have been hospitalized at least once in the past 12 months (sHR=1.08, 95% CI, 1.01-1.16) had a higher risk of NHA. Suffering from Alzheimer is the strongest predictor of NHA, with a sHR of 4.86 (95% CI, 4.48-5.27).

Sensitivity analysis

Sensitivity analysis was performed by repeating the analysis using a Cox proportional hazards regression (Table A1 in Supplementary data) and a competing risk analysis without imputation of missing values, i.e., a complete case analysis, $n = 1209$ (Table A2 in Supplementary data). Compared to the results from the competing risk analysis as presented in Table 3, we found that results from applying Cox model are overestimated in a large set of the covariates as expected and unlike the findings from the competing risk analysis, some associations were not significant (e.g., gender, educational attainment, multimorbidity, urinary incontinence, etc.). Regarding the results from the complete case analysis, although the magnitude of the associations is slightly different as compared to those after imputation, the direction of the effects and conclusions remain, in overall terms unchanged.

Discussion

To our knowledge this is the first study that investigated predictors of nursing home admission among a representative sample of the Belgian population aged ≥ 65 years.

Over the study period, 13.3% of the study population was admitted into NH and 13.2% had died without having been admitted to a NH. The overall unadjusted cumulative incidence (risk) of NHA, accounting for

death as competing risk was of 5.7% at 3 years of follow-up and of 13.1% at the end of the study. This crude risk was significantly higher among individuals with severe limitations as opposed to those without limitations. After adjusting for baseline characteristics, higher age, low educational attainment, belonging to low income household, living alone, use of home care services, history of falls, suffering from urinary incontinence, depression or Alzheimer disease, having had hospitalized in the past 12 months were significantly associated with a higher risk of NHA, while female, individuals with multimorbidity and increased contacts with health care providers were significantly associated with a decreased risk of NHA. Subjective health and limitations are both significant determinants of NHA, but subjective health is an effect modifier on the effect of limitations and vice versa.

The incidence of NHA may be influenced by organizational aspects and the cultural aspects [47], but also by the availability, accessibility and affordability of home care facilities. The characteristics of the study population also play a role since the cumulative incidence of NHA could be affected by the higher risk of death in the population under study. Previous studies have investigated predictors of NHA among sub-groups of the population. For instance, Bergkamp et al. [29] investigated predictors of NHA in Cerebral Small Vessel Disease (CSVD) patients and have found that after 5-years follow-up, the cumulative incidence was 3.6% (95% CI, 2.2-5.5) and 6% (95% CI, 4.2–8.3) after 8 years of follow-up. This cumulative incidence is lower than those found in our study. A possible explanation could be that the risk of the competing event, i.e., the death is likely higher in patients suffering from CSVD than in the general population, which may affect the risk of NHA. In contrast, our cumulative incidence is lower than the cumulative incidence found in a study in USA, 16.1% in a 2-years follow-up [48].

In earlier studies, advanced age emerged as a strong predictor of NHA among the predisposing factors [9, 22, 23]. In accordance with these studies, higher age was found to be a significant predictor of NHA, even after taking into account the competing risk of death. Furthermore, Gaugler et al. [23] showed (even if slightly high, probably due to the overestimation of Cox model) comparable result as found in this study regarding gender (female: HR of risk: 0.87 (95% CI, 0.81-0.93) vs. sHR of risk 0.75 (95% CI, 0.72-0.78). Unlike the results shown in Table 2 and also in the univariate analysis, even after taking into account the competing risk of death (sHR=1.54, 95% CI, 1.53-1.55) (results not shown), women appeared less likely to enter NH than men. One possible explanation could be related to their health status. Indeed, further analysis showed that women are more likely to suffer from multimorbidity (38.92%) than men (31.67%), $p = 0.0230$, and as our results show, multimorbidity was associated with a low risk of NHA.

It is striking that belonging to a low income household increases the risk of NHA of 29%. Previous studies also found a higher risk of NHA for individuals belonging to a low income household [43, 49]. An in-depth analysis shows that the majority of these people benefit from specific protection measures for financially vulnerable persons introduced in the health insurance system to reduce financial barriers in using care. Indeed, 52.5% of individuals admitted into NH benefited from an increased reimbursement of healthcare expenses and 77% of them have a special status for lump sum for the chronically ill. Thus, the effect of these financial protection measures could partly explain the high risk of nursing home entry for people from low income households.

Living arrangements appeared as the strongest predictor of NHA among the enabling factors. Individuals who lived alone had nearly twice the sHR to enter a NH. Our findings are in line with those in previous studies [17, 50]. Currently, people prefer living in their own home as long as possible. However, the lack of social support, but also financial problems in meeting the costs of home-based services constitute some limitations to this system. In a context where the social welfare system could cover a large part of the cost of institutionalization for individuals, an older person who lives alone might be more prone to be admitted in an institution when functional disability or health complications occur [17].

The use of home care services in the previous year was associated with the greater risk of NHA. This result is not surprising since use of home care services is generally an expression of a need for support and therefore a first step towards possible NHA. Our result is similar to those in a study on predictors of NHA after hip fracture. The authors found that receiving home care before injury was associated with an increase in HR of 2.00 (95% CI 1.54-2.61), HR 1.64 (95% CI, 1.43-1.87), and HR 1.22 [95% CI, 1.13-1.32] for patients 60 to 69 years, 70 to 79 years, and 80 to 89 years respectively [22].

Within the need factors, if either poor subjective health or severe limitations are present there is an increased risk of NHA, but when they occur together the risk of NHA decreases, most likely because for those people the risk of dying is larger than the risk of being admitted to a NH (competing risk).

Multimorbidity was associated in reducing the risk of NHA. This result could partially be explained by the effect of competing risk of death among this group. Individuals suffering from multimorbidity have also higher mortality risk and this event may arrive before NHA. Indeed, an in-depth analysis shows that among individuals suffering from multimorbidity, 93 of them (14.3%) were admitted to a NH while 118 (18.2%) died before being admitted to a NH.

In line with earlier studies [23, 51], we found that history of falls in the past 12 months was associated with an increased risk of NHA. In fact, in some cases, falls among the older people can lead to more serious events (fractures, injuries, loss of autonomy) with adverse consequences on their health status and therefore precipitate their admission to a NH.

The presence of Alzheimer's disease is by far the strongest predictor of NHA (individuals with Alzheimer's disease have 5 times more risk than those without Alzheimer's disease). In the literature, beside age, cognitive comorbidities (depression, Parkinson, dementia or Alzheimer's disease) and functional impairment were among the strongest predictors and are associated with an increased risk of NHA [9, 12, 22, 23, 52]. For example, in a study among a general older population, the authors found that Alzheimer's or dementia increases the hazard of nursing-home entry by 20.2 times for men and 10.0 times for women [9]. In another study of 137,000 community dwelling patients aged +65 years, Harris et al. found that depression was associated with a higher risk of nursing home admission in the general population [52]. Other need factors are of lesser importance.

Strengths and limitations

From a public health perspective, major strengths of the study include the use of a representative large sample and the use of a large number of individual-level predictors, a relatively long follow-up, and the linkage to administrative data to identify main risk factors of NHA. The use of the competing risk analysis is another strength of this study. Indeed, we performed competing risk regression to study the association between several covariates and the risk of NHA. This approach is preferred over a standard survival model because in older population, death may compete with nursing home admission, and ignoring such competing risk may lead to biased results [30]. In competing risk situations, the cumulative incidence function is more appropriate as it takes competing events into account when estimating the incidence. We further chose the Fine and Gray model over the cause-specific hazard model as our primary interest was in predictive modelling.

The current study has some limitations that deserves to be pointed out. First, the exact dates of NHA were not available. We used the dates of the first registered care in NH based on specific nomenclature code as a proxy of dates of NHA. However, these dates are pretty accurate and deviations from the exact dates are small. Second, almost all covariates included in the analysis were measured at baseline and most of them are self-reported. Therefore, possible changes (e.g., for living arrangements or other social supports) over the course of the study are not taken into account. Third, data on local variations in supply of care and/or home care services (supply of NH beds, hospital beds, and physicians in the region of residence, waiting lists, etc.) as potential important confounders at the enabling level were unavailable and therefore not included in our analyses. A further limitation is that our indicator of Alzheimer's disease is less sensitive due to the case definition based on prescribed specific medications. Indeed, many people with Alzheimer do not take medications. So individuals suffering from this disease might be underestimated and probably especially Alzheimer patients on medication are admitted to NH. Finally, the finding of this study may not be generalized to other areas or settings because the organization of the Belgian health care system can be very different from other countries.

Conclusions

Our findings underline important predictors of NHA of older adults, and therefore offer possibilities of prevention to avoid or delay NHA for this population. The strong impact of need factors on the risk of NHA may indicate equitable access to NHA (i.e., those in need for supports have access to NH). Practical implications include prevention of falls and appropriate and timely management of physical chronic conditions and neurodegenerative disorders. Focus should also be on people living alone to provide the appropriate social supports and access to affordable home care services. Further investigation of predictors of NHA should include contextual enabling factors such as the supply of nursing-home beds, hospital beds, physicians and waiting lists for NHA.

Abbreviations

ATC Anatomical Therapeutic Chemical

BCHI Belgian compulsory health insurance

BHIS Belgian health interview survey

DDD Daily defined dose

GALI Global Activity Limitations Indicator

HISlink linkage between BHIS data and BCHI data

IMA Inter Mutualistic Agency

LTC Long-term care

NH Nursing home

NHA Nursing Home Admission

NIHDI National Institute for Health and Disability Insurance

WHO World Health Organization

Declarations

Ethics approval and consent to participate

This study was carried out through an individual linkage between the BHIS 2013 data and the BCHI data. The BHIS 2013 was carried out in line with the Belgian privacy legislation. The BHIS 2013 has been approved by the ethics committee of the University hospital of Ghent on October, 1st 2012 (advice EC UZG 2012/658). The participation to the BHIS is voluntary. There was no formal written and signed consent foreseen. Participation was equivalent to giving consent. The selected households were notified about the survey, its practical organization, the institution in charge, the commissioners of the survey and its content via a letter and an information leaflet personally addressed to them. It was also clearly stipulated in the letter and the leaflet that participation is voluntary. All data were fully anonymized before their access. In addition, for the data linkage, an authorization was obtained from the Information Security Committee (local reference: Deliberation No. 17/119 of December 19, 2017, amended on September 3, 2019).

Consent for publication

Not applicable.

Availability of data and materials

The survey datasets and linked health administrative data analysed in the current study are not publicly available due to restrictions based in the General Data Protection Regulation (GDPR) on sensitive data such as personal health data. BHIS data contains sensitive and identifying information and therefore must only be made available upon request. Requests for data access may be made to the Social Security and Health Chamber of the Information Security Committee (hereinafter referred to as the "Social Security and Health Chamber"). Further information regarding the survey and the data access procedure can be found here: https://his.wiv-isp.be/nl/SitePages/Procedure_gegevens2013.aspx.

Competing interests

The authors declare that they have no competing interests

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Authors' contributions

FB and JVDH were responsible for designing the objectives and approach of the study. FB conducted the literature searches and summaries of previous related work, undertook the statistical analyses in collaboration with JVDH, interpreted the results, wrote the initial version of the manuscript and conducted the revisions. FB was a main contributor in writing the manuscript. JVDH, SD, RC, JV, KDR, HVO and OB critically revised the manuscript. All authors read and approved the final manuscript.

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Figures

Figure 1

Crude cumulative risk of nursing home admission, stratified by limitations (GALI), accounting death as a competing risk, HISlink 2013, Belgium

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