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Health services use and frailty among Québec seniors with a minor fracture

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MAIN FINDINGS

Among individuals aged 65 years and older having suffered a minor fracture, 13.6% were considered frail while 5.2% were robust.

This study shows that frail elderly seniors use health care more extensively after experiencing a minor fracture.

It is possible to characterize seniors' frailty status at a population level using an adaptation of a frailty index in the healthcare administrative databases.

Background

The aging of the population leads to an increase in the number of frail elderly people, thereby imposing an important burden on the planning and delivery of health services [1].

Frailty is a central concept in geriatric medicine, and is defined as a generalized reduction of homeostatic reserves in multiple physiological systems leading to a state of increased vulnerability, which makes it more difficult for elderly people to adapt to stressful life events, even minor ones (illness, accidents, etc.), and increases the risk of loss of independence [1]. For instance, it has been demonstrated that, compared to robust seniors, frail elderly individuals have a higher risk of falls [1] and a higher risk of sustaining low-trauma fractures [2, 3]. Frail community-dwelling seniors with fractures experience increased physical, emotional and social disabilities in the six months following the injury compared to those who are robust [4]. Moreover, for those who are hospitalized after such an incident, frail seniors are at increased risk of being transfered to a long-term care institution [4].

Frailty is influenced by a large range of biological, environmental and social factors [1, 5-8]. The elderly are a heterogeneous group in which the expression of frailty involves multidimensional functional losses (physical, cognitive, psychological, and social), that will likely require a broad array of health care and services [1, 9].

Québec

Currently, information on the identification of frail seniors, their health resource needs and use mostly comes from cohort studies. In such studies, frailty is generally measured using clinical indices or scales, which are typically not included in large population-based administrative databases that can be used in research or population surveillance activities to produce information supporting and improving health decision-making. However, given the expected increase in the health resources use linked to fragility, methods to identify frail seniors within such healthcare data, both at patient and population levels, are now surveillance priorities [10]. Ideally, identification of frail seniors in such databases should integrate clinical, psychological, biological, physical, cognitive and social components, in order to reflect the multidimensionality of this phenomenon.

The objectives of this study were: 1) to estimate the prevalence of frailty among seniors who have undergone a minor fracture using the Elders Risk Assessment index in Québec healthcare administrative databases; 2) to examine the association between frailty and the use of medical services in the year following a minor fracture; 3) to measure the excess consumption of health services following a minor fracture across frailty levels; and 4) to study mortality and long-term care admissions following a minor fracture.

Methods

Study design and data source

This population-based retrospective cohort study was conducted using the linked healthcare administrative databases of the Québec Integrated Chronic Disease Surveillance System (QICDSS) [11].

For the purpose of this study, the inclusion criteria below were applied:

- Aged 65 and over;
- Who had at least one medical consultation for a minor fracture between 1997 and 2014 and met the case definition of a fragility fracture [12]. In this study, a minor fracture is considered to be a fracture at an anatomical site other than the hip.

Patients who received long-term and geriatric care in the year before the fracture were excluded from the study.

Furthermore, hip fractures and fractures at another site occurring in the same year as a hip fracture were also excluded of the analyses since resource use related to each fracture cannot be distinguished. Finally, fractures associated with a missing deprivation index were also excluded. Figure 1a, presented in the appendix, shows in detail the exclusion criteria applied to obtain 178,304 fractures.

Definition of frailty

Frailty status at the time of the medical consultation for a minor fracture (index date) was measured using an adaptation of the Elders Risk Assessment index (ERA index) [13], which combines multidimensional risk factors over the two years preceding the event of interest (social, psychological, biological, clinical, cognitive and environmental components).

This weighted index assigns specific weights to each of the following factors: age, social components (marital status, race), physical components (history of diabetes, coronary artery disease, myocardial infarction, congestive heart failure, stroke, chronic obstructive pulmonary disease, cancer), cognitive components (history of cognitive impairments and dementia) and to consequences of frailty (number of hospital admission days in the two years prior to the index date). The original weights related to each of these components are described in Table 1. Theoretically, the sum of these weights allows assigning to each individual a value of the ERA index. Globally, values of this index may vary from -1 (lowest risk) to 34 (highest risk). As in Crane et al. [13], the values of the index were collapsed into five categories: robust seniors (ERA $\leq$ -1); well seniors (0 $\leq$ ERA $\leq$ 3); well seniors with treated comorbidities (4$\leq$ ERA $\leq$ 8); pre-frail seniors (9 $\leq$ ERA $\leq$ 15); frail seniors (ERA $\geq$ 16).

For adaptation of the ERA index in the QICDSS, marital status, which is a proxy for social support, was replaced by the social deprivation index quintiles. These quintiles were collapsed into three categories that were assigned weights to align with the ERA: -1 (highest support: 1st and 2nd quintile), 0 (3rd quintile), +1 (lowest support, 4th and 5th quintile) (Table 1). Information on race was not available in the administrative databases, therefore not considered. The physical and cognitive components were considered as part of the index if there was one

hospitalization or two physician billing claims associated to them and recorded at least 30 days apart, in the previous five years of the index date, excluding the 30 days prior to this date [14]. Individuals not meeting the case definitions weighted zero.

Table 1 Components of the Elders Risk Assessment index and his adaptation in the QICDSS

ERA index by Crane et al. (2010)		*Adaptation of the ERA index (QICDSS)*	
Parameters	**Weights**	**Parameters**	**Weights**
Married	-1	***Social deprivation index***	
Age		Highest support	-1
70-79	1	Average support	0
80-89	3	Lowest support	1
≥90	7	***Age***	
Race		65-69	0
Black	6	70-79	1
Other	0	80-89	3
Unknown	-6	≥90	7
Days in hospital during the previous 2 years		***Days in hospital during the previous 2 years***	
1-5	5	1-5	5
≥6	11	≥6	11
Medical history		***Medical history***	
Diabetes history	2	Diabetes history	2
History of CAD/MI/CHF	3	History of CAD/MI/CHF	3
History of stroke	2	History of stroke	2
History of COPD	5	History of COPD	5
History of cancer	1	History of cancer	1
Histort of dementia	3	Histort of dementia	3

CAD: Coronary artery disease; MI: Myocardial infarction; CHF: Congestive Heart Failure; COPD: Chronic obstructive pulmonary disease

Outcomes

Healthcare services use in the year prior to and after the index date of the medical consultation for a minor fracture was measured for three distinct healthcare services: emergency department (ED) visits, primary care practitioner (PCP) visits and hospitalizations. These events were chosen as independent outcomes, as they are associated with premature institutionalization and high utilization of health resources [13, 15, 16]. Healthcare services use within ± 7 days of the index date (date of the medical consultation for the fracture) were excluded, as they are considered to be directly associated to the fragility fracture. Long-term care admissions and mortality were also studied to better understand the possible consequences of a minor fracture in a frail individual.

Emergency department visits: Using physician-billing claims, all medical services provided by an emergency specialist or in emergency care facilities were identified. The number of ED visits was computed according to the recommendations of Belzile et al. [17], which consider only one ED visit billing for two consecutive days of ED visits billing. Moreover, all ED visits billed during a hospitalization were excluded (i.e. ED visits between admission and discharge dates in the system of maintenance and exploitation of the data for the study of the hospital customers (MED-ECHO)).

Primary care practitioner visits: Medical services with provider codes related to general practitioner and delivered in private care, outpatient or family medicine unit were selected to assess the number of PCP visits. If an individual met a PCP several times in a same day or if he had visited a PCP in two consecutive days, only one single visit to a PCP was considered.

Hospital admissions: In order to compute the number of new hospital admissions, hospital transfers were not considered as new admissions. At least one day between the previous discharge date and a new admission was required to consider a new episode. Hospital admissions whose vocation type is related to rehabilitation, psychiatric or long-term care were not considered.

Admission to long-term care: Unlike previous issues, admission to long-term care is not considered as a number of events, but rather a binary outcome (admitted or not admitted). An individual was considered to be admitted to long-term care if he meets at least one of the following three criteria: 1) be sent, after hospitalization, to a long-term care facility or to private or public, federal, provincial or outside Québec accommodation, 2) have received medical services associated with the geriatric or accommodation activity sectors, or associated with a geriatric, long-term care or hospitalization facility, public or private nursing home, 3) have a regime code 97 in the drug insurance database (specific to accommodate persons). The time between the date of fracture medical consultation and admission to long-term care was calculated using the date of first hospitalization meeting the first criterion, the date of the first medical service meeting the second criterion or the start date of regime code 97. For individuals meeting more than one criterion, the earliest date was chosen.

Mortality: An individual with a date of death in the health insurance registry in the year following the fracture was considered dead. The time between fracture and death was obtained by subtracting the date of fracture from the date of death.

Statistical Analyses

Characteristics of the study population were described using means and standard deviation (SD) for age and percentages for categorical variables. The prevalence of frailty was estimated by the proportion of individuals assigned to the ERA ≥ 16 category. Mean, median and interquartile ranges were used to describe the health resource use in the year before and after the fracture according to five frailty categories.

Multivariate Generalized Estimating Equation (GEE) models were used to examine the relationship between frailty levels and health services use while adjusting for covariates. The numbers of events (visits and hospitalizations) were modeled according to a Negative Binomial probability distribution. A binary variable corresponding to the period (before or after index date), the ERA index variable at baseline and their interaction allowed to compare the use of services over time between the five stages of frailty. Since the number of hospital days before the fracture was considered in the establishment of the ERA index, the period variable was excluded in the model evaluating the association between frailty index and number of hospital days after the fracture. The models take into consideration the difference in the number of days that each individual is at risk of using health services (i.e. exclusion of in-hospital periods for ED and PCP visits outcomes and period after death for all three outcomes) by adding as a parameter an offset variable corresponding to the time of exposure.

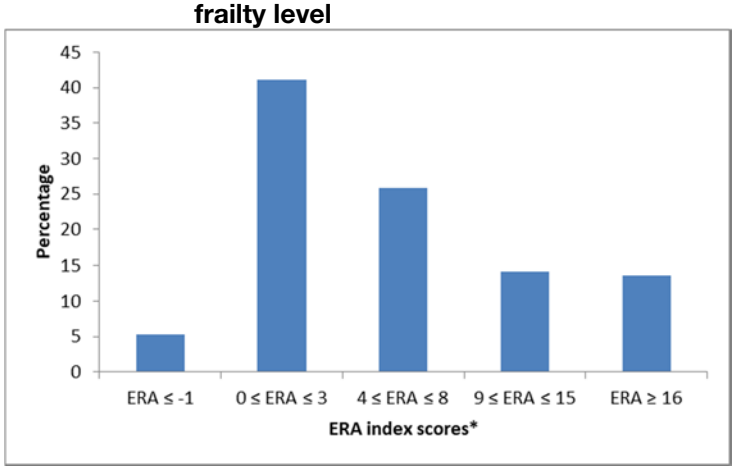
Covariables considered as potential confounding factors were sex, area of residence (rural/urban), site of fracture, number of comorbidities and material and social deprivation index. For all analyses, covariates were included in multivariate models if they were significant at a 5% alpha level.

The same covariates were considered in Cox regressions (proportional hazard models) to study time to death on the one hand and time to admission to long-term care on the other hand. Individuals who had no event in the year following the fracture were censored. For the analysis of long-term care admissions, individuals who died before such admission were also censored at the death date. All postulates concerning the construction of the different models have been verified. Data were analyzed using the 9.4 version of the SAS statistical software.

Results

The cohort consisted of individuals aged 65 and over. Mean age was 75.5 years and 74.2% were women. The most common fractures were wrist (20.0%), humerus (18.7%) and elbow (12.3%). The ERA scores ranged from -1 to 32. There were 13.6% frail seniors, while 5.2% were considered as robust. The complete distribution of the cohort according to frailty level is presented in Figure 1.

Figure 1 **Distribution of the cohort according to frailty level**



* ERA ≤ -1 : Robust, 0 ≤ ERA ≤ 3 : Well, 4 ≤ ERA ≤ 8 : Well/comorbidities, 9 ≤ ERA ≤ 15 : Pre-frail, ERA ≥ 16 : Frail

Table 2 Characteristics of study cohort at index visit for a minor fracture according to frailty levels

Characteristics	Robust ERA ≤-1	Well 0 ≤ ERA ≤ 3	Well/ comorbidities 4 ≤ ERA ≤ 8	Pre-frail 9 ≤ ERA ≤ 15	Frail ERA ≥ 16	Total
N (%)	9.345 (5.2)	73.400 (41.2)	45.984 (25.8)	25.322 (14.2)	24.253 (13.6)	178.304
Sex (%)						
Women	69.6	75.6	75.0	72.0	72.0	74.2
Men	30.4	24.4	25.0	28.0	28.0	25.8
Age, mean (SD) (ERA index component)						
65 and over	66.9 (1.4)	72.7 (5.4)	78.3 (7.4)	77.9 (8.1)	79.7 (7.7)	75.5 (7.5)
Number of comorbidities (%)						
0-1	85.3	69.8	43.0	18.5	4.0	47.5
2-4	14.6	29.0	49.8	57.2	37.3	38.8
≥ 5	0.1	1.2	7.2	24.2	58.7	13.8
Social deprivation index (%) (ERA index component)						
1 (highest support)	46.7	14.9	9.8	12.7	10.5	14.3
2	53.3	17.3	11.8	15.5	13.1	17.0
3	N/A	25.2	16.2	18.6	18.5	19.7
4	N/A	20.9	29.0	24.3	25.9	23.0
5 (lowest support)	N/A	21.8	33.2	29.0	32.1	26.0
Material deprivation index (%)						
1 (highest support)	17.9	19.1	19.0	17.6	15.8	18.3
2	18.5	18.4	18.4	17.8	17.8	18.2
3	19.4	20.1	19.7	20.3	20.5	20.1
4	20.8	21.1	21.9	21.5	22.1	21.5
5 (lowest support)	23.5	21.3	21.0	22.8	23.8	21.9
Site of fracture (%)						
Lower limbs	43.7	37.1	33.9	35.0	32.3	35.7
Upper limbs	49.9	55.4	55.6	52.1	51.2	54.1
Pelvis	1.8	2.6	3.9	4.7	5.9	3.6
Spine	4.6	4.9	6.6	8.2	10.6	6.6
Area of residence (%)						
1 (Montreal CMA)	37.0	44.5	46.8	42.9	41.6	44.1
2 (Other CMAs)	16.9	18.5	19.6	18.9	19.7	18.9
3 (Agglomerations)	11.2	13.5	14.8	15.6	17.5	14.6
4 (Rural areas)	34.9	23.5	18.9	22.6	21.2	22.5
Physical and cognitive ERA (%) (ERA index components)						
Diabetes	0.0	8.6	22.3	23.6	34.5	17.3
CAD/MI/CHF	0.0	4.4	34.0	47.1	75.0	27.5
Stroke	0.0	1.1	6.8	13.6	25.1	7.5
COPD	0.0	0.0	10.4	26.5	51.3	13.4
Cancer	0.0	9.7	13.7	19.6	22.1	13.3
Dementia	0.0	0.2	3.8	7.0	14.8	4.1

CMA: Census metropolitan area; CAD: Coronary artery disease; MI: Myocardial infarction; CHF: Congestive Heart Failure; COPD: Chronic obstructive pulmonary disease; N/A: Not applicable.

Characteristics of study cohort at index visit according to individual's frailty levels are presented in table 2. Briefly, the proportion of patients with 5 or more comorbidities increased with frailty levels from 0.1% for robust seniors to 58.7% for frail ones. Furthermore, 51.3% of frail seniors had a history of chronic obstructive pulmonary disease (COPD), 75.0% had a history of coronary artery disease (CAD), myocardial infarction (MI) or congestive heart failure (CHF) and 34.5% had a history of diabetes. Robust patients have more fractures in the lower limbs, while the more fragile have more fractures in the pelvis and spine.

Table 3 Association between frailty and healthcare services use

Frailty	Before index date			After index date			Interaction (frailty*period)
	%	Mean (Median, Q1-Q3)	Adjusted RR (CI)	%	Mean (Median, Q1, Q3)	Adjusted RR (CI)	Adjusted RR (CI)
	Emergency Department (ED) visits						
Robust (ERA ≤-1)	19.9	0.32 (0, 0-0)	REF	31.4	0.55 (0, 0-1)	REF	1.80 (1.65-1.96)
0 ≤ ERA ≤ 3	23.3	0.37 (0, 0-0)	1.09 (1.00-1.20)	35.8	0.64 (0, 0-1)	1.20 (1.12-1.27)	1.96 (1.89-2.04)
4 ≤ ERA ≤ 8	32.8	0.55 (0, 0-1)	1.47 (1.35-1.61)	45.8	0.91 (0, 0-1)	1.63 (1.53-1.75)	1.99 (1.92-2.06)
9 ≤ ERA ≤ 15	54.4	1.11 (0, 0-2)	2.56 (2.33-2.81)	55.1	1.24 (1, 0-2)	2.06 (1.92-2.21)	1.44 (1.38-1.51)
Frail (ERA ≥16)	75.3	2.03 (1, 1-1)	4.12 (3.74-4.55)	64.7	1.70 (1, 0-2)	2.69 (2.50-2.90)	1.17 (1.13-1.22)
	Primary care practitioner (PCP) visits						
Robust (ERA ≤-1)	79.8	2.92 (2, 1-4)	REF	81.8	3.19 (2, 1-4)	REF	1.12 (1.09-1.14)
0 ≤ ERA ≤ 3	83.5	3.51 (3, 1-5)	1.14 (1.11-1.18)	84.3	3.69 (3, 1-5)	1.12 (1.09-1.16)	1.10 (1.09-1.11)
4 ≤ ERA ≤ 8	88.4	4.50 (4, 2-6)	1.33 (1.29-1.37)	85.1	4.38 (3, 1-6)	1.26 (1.22-1.30)	1.06 (1.05-1.07)
9 ≤ ERA ≤ 15	89.0	5.19 (4, 2-7)	1.43 (1.38-1.48)	82.3	4.54 (3, 1-6)	1.26 (1.22-1.30)	0.98 (0.97-1.00)
Frail (ERA ≥16)	88.9	5.87 (5, 2-8)	1.53 (1.47-1.59)	77.0	4.59 (3, 1-7)	1.28 (1.23-1.32)	0.93 (0.91-0.95)
	Number of hospital admissions						
Robust (ERA ≤-1)	4.8	0.06 (0, 0-0)	N/A	19.7	0.26 (0, 0-0)	REF	N/A
0 ≤ ERA ≤ 3	6.9	0.09 (0, 0-0)	N/A	23.5	0.32 (0, 0-0)	1.26 (1.17-1.36)	N/A
4 ≤ ERA ≤ 8	14.6	0.18 (0, 0-0)	N/A	45.8	0.44 (0, 0-1)	1.66 (1.53-1.80)	N/A
9 ≤ ERA ≤ 15	43.0	0.58 (0, 0-1)	N/A	39.6	0.61 (0, 0-1)	1.96 (1.81-2.13)	N/A
Frail (ERA ≥16)	67.0	1.16 (0, 0-2)	N/A	27.9	0.87 (0, 0-1)	2.34 (2.14-2.55)	N/A
	Number of hospital days						
Robust (ERA ≤-1)		0.0 (0,0-0)	N/A		3.35 (0, 0-1)	REF	N/A
0 ≤ ERA ≤ 3		0.0 (0, 0-0)	N/A		5.74 (0, 0-3)	2.15 (1.89-2.45)	N/A
4 ≤ ERA ≤ 8		0.18 (0, 0-0)	N/A		10.46 (0, 0-10)	4.57 (4.00-5.22)	N/A
9 ≤ ERA ≤ 15		4.22 (0, 0-4)	N/A		14.76 (2, 0-17)	5.48 (4.76-6.31)	N/A
Frail (ERA ≥16)		12.54 (7, 0-17)	N/A		21.80 (9, 0-29)	7.57 (6.56-8.74)	N/A

RR: Relative Risk; REF: Reference category; N/A: Not applicable; CI: 95% confidence interval.

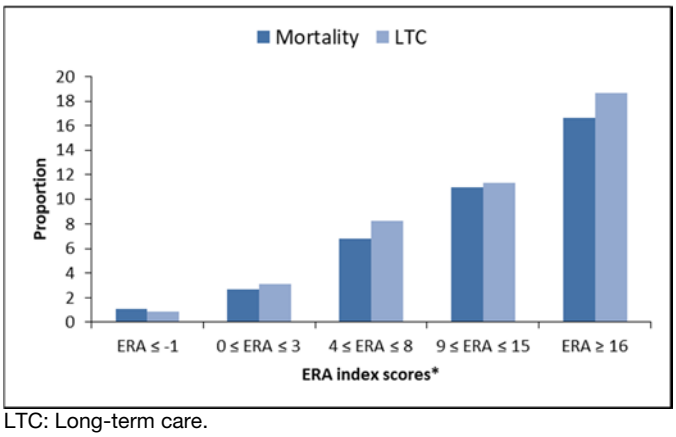
Table 3 illustrates the mean number of ED and PCP visits as well as hospitalizations one year before and one year after the minor fracture according to frailty levels. Overall, 64.7% of frail seniors returned to ED and 27.9% were admitted to hospitals in the year following the minor fracture, while these proportions were significantly lower in robust individuals: 31.4% and 19.7% respectively.

For each type of service, there is a significant increase in health resource use with increased frailty levels. The multivariate regression analyses show that each increase of frailty levels is associated with a statistically significant increase in the adjusted risk for ED visits, both in the year before and after the fracture. For instance, compared to robust seniors, frail ones were more than four times more likely to visit the ED (RR: 4.12; 95% CI:

3.74-4.55) in the year before sustaining their fracture and more than two times more (RR: 2.69; 95% CI: 2.50-2.90) in the year post-fracture. The incidence of a fracture has therefore reduced the gap between robust and frail. Similarly, the risk of PCP visits was also significantly higher in each level of frailty, both before and after the fracture. In frail seniors, the adjusted risk of PCP visits was 1.53 (95% CI: 1.47-1.59) in the year before the fracture and 1.28 (95% CI: 1.23-1.32) in the year post-fracture. In the year after the minor fracture, analyses also show a statistically significant increase in the risk of hospital admissions and hospital days with frailty levels. Indeed, compared to robust seniors, frail ones have an adjusted risk of 2.34 (95% CI: 2.14-2.55) for hospital admissions, and an adjusted risk of 7.57 (95% CI: 6.56-8.74) for the number of hospital days in the year following the fracture.

Finally, the interaction variable between frailty and the period shows that for each level of frailty, the excessive use of ED visits and PCP is potentially associated with the fracture. Compared to the year before the fracture, our results suggested a two-fold increase in the risk of ED visits in three levels of frailty (robust, well, and well with treated comorbidities). In pre-frail and frail seniors, the risk of emergency room visits increased by 1.44 and 1.17, respectively, in the post-fracture period compared with the pre-fracture period. We found that the use of services increases more in robust, well, and well with treated comorbidities seniors than in the two fragile levels. Finally, compared to the year before the fracture, the risk of visiting a PCP in the post-fracture period increased only slightly among the robust, well, and well with treated comorbidities groups. This risk decreases among fragile groups.

Figure 2 **Long-term care admissions and mortality, by frailty level**

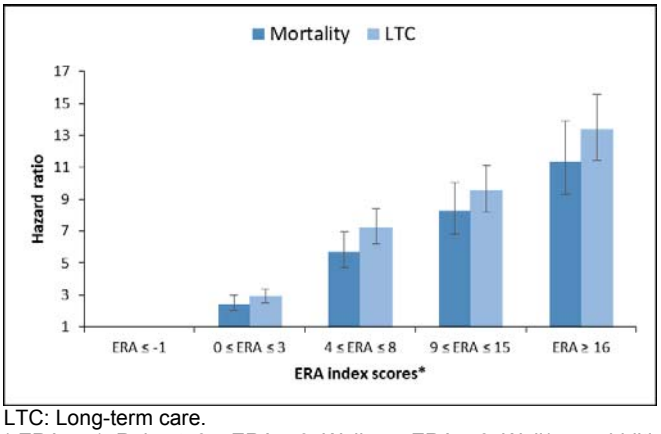


LTC: Long-term care.

* ERA ≤ -1: Robust, 0 ≤ ERA ≤ 3: Well, 4 ≤ ERA ≤ 8: Well/comorbidities, 9 ≤ ERA ≤ 15: Pre-frail, ERA ≥ 16: Frail.

Figure 2 shows an increase in the proportion of long-term care admissions and deaths in the year following the fracture by frailty. More than 16.0% of frail people are admitted to long-term care or have died following the medical consultation for a minor fracture. It can be assumed that the decrease in the use of services (emergency and PCP) among the fragile groups is justified by these higher proportions of long-term care admission and death than in the other groups.

Figure 3 **Survival analysis for long-term care admissions and mortality, by frailty level**



LTC: Long-term care.

* ERA ≤ -1: Robust, 0 ≤ ERA ≤ 3: Well, 4 ≤ ERA ≤ 8: Well/comorbidities, 9 ≤ ERA ≤ 15: Pre-frail, ERA ≥ 16: Frail.

Figure 3 shows hazard ratios from the survival analyses for mortality and long-term care admissions by frailty level. For each increase in the frailty level, there is a significant increase in the risk of being admitted to long-term care or death in the year following the fracture. Compared to robust seniors, the relative risks of admission to long-term care and death were 13.4 (95% CI: 11.4-15.6) and 11.4 (95% CI: 9.3-13.9) in frail elderly individuals.

Discussion

In this study, we have attempted to characterise the frailty by reproducing the Elders Risk Assessment (ERA index) using the QICDSS databases. This reproduction allowed us to identify a sub-group of frail individuals at high risk of medical resources use (ED, PCP, hospitalizations) in the year following a medical consultation for a minor fracture. Several studies have developed frailty indexes but few have focused on identifying frail seniors in large medico-administrative databases used for surveillance and research activities.

We chose to reproduce the ERA index for its multidimensional aspect and for its applicability in administrative data. In addition, our results reflect the actual use of health services by seniors, as opposed to cohort studies that rely on clinical evidence of frailty and self-reported service use.

Our findings on frailty prevalence are consistent with the results obtained in the systematic review conducted by Collard et al. [18]. These authors compiled the results on frailty prevalence of 21 different studies (with a total of 61,500 participants) and observed a frailty prevalence of 10.7% among seniors aged 65 and over (95 % CI: 10.5-10.9) while we observed a frailty prevalence of 13.6%. Our slightly higher prevalence is most likely due to the nature of our population of older individuals who had sustained a fracture event.

Our results also concurred with other studies, including the ERA validation study [13], which included 12,650 community-dwelling seniors aged 60 and over. Among these individuals, 16.7% were in the robust group while 9.4% were in the frailest group. This study identifies more robust people than ours, again because we selected a cohort of fractured elders and not a general population of seniors. Crane et al. also analyzed the number of emergency department visits and hospitalizations in the subsequent two years following an assignment to a primary care internal medicine provider. They found that compared to the robust group, the most frail individuals had a relative risk of 9.5 (95% CI: 8.1-11.2) for either hospitalizations or ED visits, and a risk 13.3 (95% CI: 11.2-15.9) times higher for hospitalization alone over a two year period.

Our results suggest that special attention should be paid to elderly patients. Among frail seniors, fracture may have an impact on services consumption, which should result in additional assessment and attention as soon as the patient visits a health professional, even for a minor fracture. Indeed, in a prospective cohort study, Provencher et al. found that emergency department consultation following a minor injury was associated with decreased quality of life and increased functional decline six months after injury, and frail seniors were 10 times more at risk of this decline [19, 20]. Our statistical models also suggest that, after a fracture, the increase use of health services in the ED and PCP is higher among seniors who are not frail, compared to frail individuals who were already heavy users of services before their fracture. This is consistent with the fact that for the most fragile people, the consequences of a minor fracture are much more serious. Indeed, they unfortunately suffer a significant functional decline leading to more hospitalizations, admissions to long-term care or sometimes even death. In addition, the increased use of health care that we have seen among pre-frail seniors clearly supports the importance of addressing frailty in primary care (for example, emergency and front-line services) to identify pre-frail seniors.

This study demonstrates that it is possible to characterize frailty among seniors using information collected in the medico-administrative databases. Since the aging of the population is now a public health priority, it is therefore important to further integrate frailty into the different surveillance activities. Data from this surveillance will allow producing relevant information to identify subgroups of the population at risk. These information are important for evaluation and implementation of various effective prevention strategies, and for the planning of the health services that will be used by this population. Frailty prevention can be done by offering better care for seniors and working on

preventive measures for each of its components (social, physical and cognitive). Indeed, better treatment can probably result through tighter medical follow-up in primary care. In addition, all public health programs aimed at maintaining physical and cognitive health and social participation through community action must be widely promoted, supported and strengthened. From a public health perspective, these preventive measures can directly contribute to limiting the progression of frailty among seniors. It is also possible to think that better follow-up in primary care combined with strong public health actions can contribute to reduce pressure on emergency departments and hospitalizations related to episodes of exacerbation of health problems.

This study has limitations. First of all, even if we used validated algorithms for our analyses, the use of administrative databases may lead to possible omissions or coding errors. We also used these data to identify comorbid conditions included in the ERA index. These may under-estimate secondary diagnoses, however, other authors have found that administrative data such as ICD-9 and ICD-10 codes typically correlate well with patient chart diagnoses.

We did not perfectly replicate the ERA index. Indeed, we used the social deprivation index instead of the simple marital status, this last information not being available in QICDSS. However, our index does include, for a given census territory, the proportions of single-parent families, of widowed, separated or divorced people and of people living alone. Although it is not an individual information, we consider the deprivation index is a valid substitute, since it combines three reliable indicators instead of using only one. Moreover, we could not included the race of the individual. Because the Québec population has a Caucasian population of over 89%, and only 3% black population [21], the lack of ethnicity in the measurement of frailty likely has a limited impact.

Finally, the use of health administrative databases for a health study inevitably leads to a lack of clinical information. However, the results obtained in the databases are consistent with the cohort studies on similar issues [22, 23, 24, 25].

Conclusion

There are many reasons to measure frailty, including the identification of people who are at an increased risk of adverse health outcomes [26]. This population-based study suggests that seniors identified as frail by the ERA index and sustaining relatively minor fractures use more health services in the year pre- and post-fracture. The fracture may have an impact on seniors' service consumption, which should result in additional assessment and attention as soon as the patient visits a health care professional for a minor fracture. This use of Québec healthcare administrative databases indicates that, from a public health perspective, it is possible to use a frailty index to improve the monitoring of chronic diseases.

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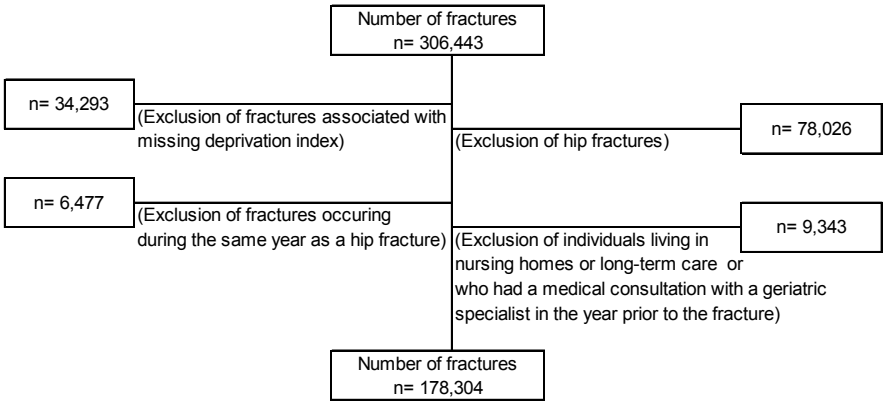
Appendices

Figure 1a Flow chart of the study



List of codes used for the «Elders Risk Assessment index»

	CIM-9	CIM-10
Physical components		
Diabetes	250	E10, E11, E12, E13, E14
Coronary artery disease	410, 411, 412, 413, 414, 4292	I20, I21, I22, I23, I24, I25
Myocardial infarction	4100, 4101, 4109, 4110, 4111, 4116, 4119, 4120, 4128, 4129	I21, I22, I252
Congestive Heart failure	39891, 40201, 40211, 40291, 40401, 40403, 40411, 40413, 40491, 40493, 4254, 4255, 4256, 4257, 4258, 4259, 428	I099, I110, I130, I132, I255, I420, I425, I426, I427, I428, I429, I43, I50, P290
Stroke	430, 431, 432, 433, 434, 435, 436, 437, 438	I6
Chronic obstructive pulmonary disease	491, 492, 496, 5064	J41, J42, J43, J44
Cancer	14, 15, 16, 161, 162, 163, 170, 171, 172, 174, 175, 176, 177, 178, 179, 18, 19, 200, 201, 202, 2030, 2386	C0, C1, C20, C21, C22, C23, C24, C25, C26, C30, C31, C32, C33, C34, C37, C38, C39, C40, C41, C43, C45, C46, C47, C48, C49, C50, C51, C52, C53, C54, C55, C56, C57, C58, C6, C70, C71, C72, C73, C74, C75, C76, C77, C78, C79, C80, C81, C82, C83, C84, C85, C88, C96, C97, C900, C902
Cognitive component		
Dementia	290, 2941, 3312	F00, F01, F02, F03, F051, G30, G311

CIM-9: Classification internationale des maladies, 9e version; CIM-10: Classification internationale des maladies, 10e version.

Health services use and frailty among Québec seniors with a minor fracture

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