The European Journal of Public Health, Vol. 28, No. 5, 842–846

doi:10.1093/eurpub/cky006 Advance Access published on 26 March 2018

Frailty as a predictor of mortality and hospital services use in older adults: a cluster analysis in a cohort study

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Background: Lowering mortality and hospitalization of older adults is one of the main goals of public health to improve both health systems' sustainability and older adults' quality of life. The aim of this study is to identify the determinants associated with mortality and the use of hospital services in the population older than 64 years of age. **Methods:** A randomized sample from the population of the Lazio region (Italy) above the age of 64 was enrolled in 2014 by the administration of a questionnaire to assess frailty; the rates of use of hospital services and mortality in the year following the enrolment have been retrieved by the regional database. Univariable and multivariable analyses addressed the association of health status, social and economic variables with health outcomes. **Results:** One thousand two hundred and eighty persons were recruited; 52 deaths were reported at 1 year of follow-up (robust 1.8%, frail 10.1% and very frail 19.1%, $P < 0.001$). The mean rate of use of hospital services was 692.2 per 1000 observation/year (robust 589.5, frail 1191.1 and very frail 848.4, $P < 0.001$). In the multivariate analysis, the higher rate of use of hospital services was independently associated with functional status, social support, psychological/psychiatric discomfort, availability of home care services and physical health. **Conclusions:** Frailty, as a multidimensional issue, is also a strong predictor of survival in the short term. The use of the hospital services by older adults is associated mainly with functional status, social resources, psycho-physical status and health service organization factors.

Introduction

Frailty is the background to the functional decline of older adults: it is determined by physical, psychological and socio-economic domains[1,2] and it is associated with a major use of the health services not only hospital-based ones.[3–5] Over the last few decades, there has been a new vision of frailty in older adults, growing and developing in accordance with the WHO's theory of health determinants.[6] It recognizes the multidimensional nature of aging and bases its main domains not only on the physical but also on psychological, social and economic factors.[7–9] Many authors, in fact, underline the crucial role played by social factors, like social isolation,[10] as well as physical, psychological and cognitive ones, in increasing the higher vulnerability to stressors that is the expression of frailty status. From a public health point of view, the multidimensional approach to frailty allows to stratify the risk of negative events also in sub-populations which do not show functional decline yet. The impact of social and economic determinants on health is an asset of historic significance of global public health and informs the policies of supporting population health.

The increasing risk for hospitalization and death determined by frailty status is demonstrated by a wide literature.[11–13] The study of the role played by frailty determinants in increasing mortality and hospitalization rate[14–17] could provide useful information to reduce both of these. Moreover, recent studies focus on the complex bidirectional relationship between frailty and admission to hospital and the adverse consequences for frail older adults of the acute care stay.[18] Since hospital care is the main component of health care costs, detecting the determinants connected to the use of hospital services (UHSs) is crucial to plan efficient actions aimed at improving the quality of life and health outcomes among frail persons as well as improving the sustainability of health systems. However, the contribution of each domain to an increased of UHS risk is not yet adequately taken account of. It could be the basis for planning an improved strategy to prevent or manage frailty in community-dwelling older adults.

The aim of the present cohort study is to identify the impact of frailty and its main determinants on the mortality and hospitalization on a sample of community-dwelling older adults residents in Lazio Region, Italy.

Methods

The study design is an observational longitudinal cohort study and it has been approved by the Independent Ethical Committee of the University of Rome 'Tor Vergata'. The cohort was selected in 2014 by an assessment of frailty carried out on a random sample of older adults representative of the population of the Lazio region (Italy).[19] The selection procedure is composed by several steps: (i) select the geographical areas representative of the whole Lazio region on the basis of socio-economic condition, dependency index, topography and number of inhabitants; (ii) by a random procedure, select the general practitioners to be involved in the study taken from the list

available at local health authorities included in the selected geographical area; (iii) on the GP's list of the over-65-year-old patients, randomly select 25 names to be contacted for frailty assessment. The study addressed community-dwelling older adults, so that all the selected persons living in an institution were excluded. In the case that the subject was not able to complete the questionnaire himself, it was filled in by the closest informal career. At enrolment, a first level multidimensional questionnaire for the assessment of frailty (the functional geriatric evaluation—FGE)[20] was filled in by all participants to assess their frailty level. The questionnaire explored five domains: physical health, mental health, social resources, economic resources and functional status. The questionnaire's final score (FS) could be grouped in three levels of frailty (final synthetic score—FSS):

(1) The person is 'robust' (FS > 49);
(2) The person is defined as 'frail' (FS 11–49);
(3) The person is defined as 'very frail' (FS < 11).

The presence/absence of a list of 21 diseases is also ascertained by interviewing the citizen's general practitioner (Supplementary table 1). The questionnaire has been validated for predicting events like death, hospitalization and institutionalization over a range from 1 to 5 years of observation.[20,21]

Data regarding death, hospital admissions (acute care and day hospital care) and emergency department visits (EDVs) were retrieved annually by the regional database that is fed by the standard data flow. The UHS was calculated as the sum of hospitalization plus EDVs not resulting in hospital admission plus the use of day hospital services in the first year after the questionnaire administration. The 62 variables explored by the FGE questionnaire (included 21 diseases—table 1 and Supplementary table 1) have been matched with the dichotomized UHSs (any vs. no) to select the ones to be included in the multivariable model according to a Chi-square value < 0.05. On the basis of the FS of the FGE and of the rate of UHS per year the sample was sub-divided into four groups (A–D) by a K-means clustering technique. Belonging to one of the four clusters was the outcome variable of the main analysis. The four clusters have been matched with all the variables independently associated with the UHS were grouped according to the domain to which they belonged and included in the final model as dichotomous variables (no deficits vs. any deficit).The final model included also gender, age, FSS and comorbidity as control variables, all but the FSS being treated as categorical variables. Moreover, a survival analysis was carried out by Cox proportional hazard regression.

Results

The sample was made up by 1 335 persons (610 males, mean age 75.8 with a SD ± 6.8 and 726 females, mean age 76.7 with a SD ± 7.3). Fifty-five of 1 335 persons (4.1%) were lost to follow-up during the first year: they did not differ in age or gender from the persons retained into the follow-up. At the baseline assessment the 'very frail', 'frail' and 'robust' were 94 (7.3%), 178 (13.9%) and 1008 (78.8%), respectively. During the first year of follow-up, 52 deaths were observed (4.2%); the recorded mortality rate was higher among the 'very frail' (19.1%) and the 'frail' (10.1%) compared with the 'robust' (1.8%, $P < 0.001$). In the multivariable model, adjusted for age, gender and comorbidity, a statistically significant association was observed with the FSS, the presence of dental diseases and of severe cognitive impairment (table 1).

The UHSs during the first year of follow-up was also associated with baseline frailty as it is shown in table 2. Interestingly, the highest rate of UHS is among the 'frail' individuals rather than among the 'very frail'; this is mainly due to their having the highest rate of access to the emergency department not resulting in a hospital admission. Moreover, the multivariable analysis performed with frailty as a predictor of UHS, gave poor results (Supplementary table 2). After the clustering, the sample was classified in four groups according to the FS and the rate of UHS (table 3): two of them showed the highest rates of UHSs (957.4 and 932.1 per 1000/obs years for clusters A and B, respectively) while the third one (cluster C) showed an intermediate rate (672.1) and the fourth one (cluster D) the lowest rate (594.5). It is worth noting that clusters A and D showed a mean FS higher or very close to 50, which is the threshold between the 'frail' and the 'robust' state, while the remaining clusters were fully in the area of the 'very frail' persons (mean FS equal to −9.8 and −69.7 for clusters B and C, respectively). The clustering permitted identification of a group of interviewees (cluster A) with the highest rate of UHS associated with a moderate level of frailty or even with a status of 'robust' (FS mean value = 42.59, SD ± 11.59), showing that the score of the frailty questionnaire is not the best predictor of UHSs, at least in the short term. To understand which factors could be associated with higher rate of UHS, a further analysis was performed. Each variable included in the questionnaire have been matched as a categorical one with the UHSs (yes vs. no). The variables that resulted to be associated to the outcome (table 4 Chi-square: $P < 0.05$) were included in the multivariable analysis as predictors; the variable of the same functional domain have been grouped all together and included as a dichotomous one in the analysis (table 4). The higher rate of UHS was associated to the patients with impairment in performing some ADLs (OR = 14.3; CL 95%: 6.8–30.2), lack of social support (OR = 11.8; CL 95%: 4.9–28.1), psycological/psychiatric discomfort (OR = 8.8; CL 95%: 4.6–16.9), lack of home care services (OR = 3.5; CL 95%: 1.8–6.5) and with physical impairment (OR = 3.3; CL 95%: 1.7–6.5) $R^2 = 0.79$. The same multivariable analysis, carried out after stratification for FSS and comparing individuals who did not use HSs at all with the ones who used them at least once in the first year of follow-up, showed the major impact of functional and social factors in determining the higher hospitalization rate among the robust individuals and the increasing relevance of diseases (namely cardiopathy and nephropathy) among the frail/very frail when the FS decreases (Supplementary tables 3 and 4).

Conclusions

The study shows that frailty is predictive of mortality and hospitalization in the short term; this is in addition to its predictive power in the medium-long term, already pointed out in other studies. This result is of value at an individual level especially for care providers, who can refer the patients with higher risk of death for a more extensive assessment aimed to provide a pattern of personalized care services. An assessment of frailty is obtained by administering a short questionnaire that does not require either a prolonged training or a high professional qualification to be administered. It could be the first step of the personalized *prise en charge* process to be implemented in the community to identify patients who will require a high level of care in the following 12 months.

The association is weaker for the hospitalization rate than for the mortality rate as has also pointed out in the literature.[22,23] In this study, the cluster A, with a FS lying on the threshold of frailty, shows the highest hospitalization rate. This important finding, confirmed by other studies which recognize the key role of the pre-frail population in the use of health services,[24] addresses the need of specific services for this population.[25,26]

The higher rate of UHS in the older adult population is associated mainly with functional, social and health service organization factors. The role played by the lack of oral health could be explained by the association of this condition with malnutrition, and a lack of social and economic resources.[27,28] Moreover, there is evidence of a link between periodontal disease and systemic inflammation that could help to explain this result from the study.[29] Actions addressing functional, social and economic factors are probably the most effective in reducing the hospitalization rate of older adults. In fact, the analysis showed a variable relationship between the rate of UHS and the prevalence of diseases: the greater the frailty, the more diseases,

Table 1 Risk of death according to frailty and prevalence of dental diseases and neurological diseases

		RR	CI 95.0%	
			Lower	Upper
Gender	Male	1.0		
	Female	0.4	0.2	0.6
FSS	Robust	1.0		
	Frail	**4.9**	2.4	9.7
	Very frail	**7.8**	3.7	16.4
Dental diseases	No	1.0		
	Yes	**1.8**	1.1	3.8
Dementia	No	1.0		
	Yes	**2.9**	1.4	6.0
Age	>75	1.0		
	<75	0.4	0.2	0.9
Comorbidity	Yes	1.0		
	No	0.2	0.1	1.6

multivariable Cox proportional hazard risk.

Table 2 Rate of UHS per 1000 obs/y according to baseline frailty status

		N	Mean	SD	*P*
Cumulative rate	Robust	1008	589.5	1131.1	<0.001
	Frail	178	1191.1	2613.7	
	Very frail	94	848.4	1639.6	
	Total	1280	692.2	1480.8	
EDVs not resulting in hospital admission	Robust	1008	344.1	782.4	0.02
	Frail	178	649.5	2028.2	
	Very frail	94	445.6	1107.5	
	Total	1280	394.0	1073.2	
Day hospital	Robust	1008	81.2	343.3	0.012
	Frail	178	156.9	707.0	
	Very frail	94	10.6	103.1	
	Total	1280	86.6	404.8	
In-patient admissions	Robust	1008	164.2	651.9	<0.001
	Frail	178	384.7	1083.7	
	Very frail	94	392.1	1127.9	
	Total	1280	211.6	773.3	

Table 3 Distribution of patients according to the FS of the questionnaire and the cumulative rate of UHS per 1000 obs/y

Cluster	FS			Cumulative rate of UHS per 1000 obs/y			
	Mean	SD	*P*	*N*	Mean	SD	*P*
A	42.59	11.52	<0.001	266	957.4	2230.26	0.002
B	−9.90	14.09		79	932.1	1796.41	
C	−69.74	18.49		23	672.1	872.28	
D	72.16	7.06		912	594.5	1141.08	
Total	58.40	29.18		1280	692.2	1480.84	

namely cardiopathies and nephropathies, become determinants of a higher rate of UHS. This result should lead to different approaches to minimize UHS according to the degree of frailty. Since the biggest share of UHS (~70% of inpatients admissions and EDVs not resulting in admission as well as of hospital stay, data not shown—Supplementary table 5), however, is generated by 'robust' individuals, any interventions aimed at preventing the functional decline and managing social frailty are probably the most effective to reduce the overall rate of UHS. The hospital services organization could also contribute to address the needs of care generated by the older adults population: strengthen the diagnostic services and shorten the waiting list for the outpatient specialist care are probably effective interventions to meet the need of care of the robust citizens as well as of the ones who experience an initial physical impairment. The frail and the very frail patients need effective and timely inpatients acute care services and a post-acute care focused on the frailty status to reach the highest level of self-sufficiency according to the individual health status.

This study provides information observed in an Italian region characterized by low provision of social and out-of-hospital health care.[30] The inpatient admission rate of the sample is in line with the Lazio regional rate.[31] However, the Lazio regional inpatient admission rate is in line with the Italian national mean, which is one of the lowest rates in Europe.[32] The main determinant of the older adults' acute hospital admissions' rate at national level in the last 20 years in Italy has been the availability of hospital beds. The Lazio region is projected to further reduce the rate of hospital beds for acute care from 3.4 to 3 per 1000 inhabitants according to the law of 2012.[33] This

Table 4 Multivariable Logistic Regression; outcome variable: being part of cluster 1 vs cluster 4

Variable	Univariate analysis		Multivariable Logistic Regression			
	Chi^2	P		OR	CL 95%	
					Lower	Upper
Mobility (a. Fully mobile, dresses, carries parcels, rides bus; b. uses cane or should use one, dependent on railings; c. requires cane & other support - wheelchair)*	38.05	0.004	Physical health	3.35	1.85	6.54
Respiratory and cardio-vascular function (a. no restrictions; b. 1 flight of stairs/1 city block; c. partly or totally bedridden)*	12.86	0.002				
Diet (Restrictions vs no Restriction)*	9.98	0.002				
Reads and writes letter (No/Yes)°	18.19	0.033	Functional status (any impairment vs. no impairment)	14.33	6.79	30.21
Able to use the telephone (No/Yes)°	34,32	<0.001				
Washes and dresses (No/Yes)°	17.33	0.044				
Disorientation (a. None; b. Time; c. Person &/or Place)**	36,73	0.006	Psychological/ Psychiatric Health	8.79	4.56	16.94
Energy and drive (Normal; b. Hypoactive or Hyperactive)**	22.24	0.008				
If living alone can get support from a reliable relative, friend, neighbour, concierge (No/Yes)	28.32	0.001	Social Support	11.82	4.97	28.09
Availability of home care services (No/Yes)	4.43	0.035	Health service organization	3.48	1.85	6.54
Dental diseases (No/Yes)	3.6	0.045	Disease	2.43	1.01	5.37
Gender (Male vs Female)	9.05	0.003		2.64	1.47	4.73
Age (<75 vs >75)	3.76	0.052	Control variables	2.45	1.37	4.38
Final Synthetic Score (FSS)	2.72	0.099		0.99	NS	
Comorbidity (0, 1, >1)	0.72	0.396		0.77	NS	

All covariates but Final Synthetic Score are treated as categorical: R^2 di Nagelkerke = 0.829.
*In the multivariable analysis these variables are analyzed all together as Physical health.
°In the multivariable analysis this variables are analyzed all together as Functional status.
**In the multivariable analysis these variables are analyzed all together as Phychological/Psychiatric Health.

reduction could be managed only by taking care of the factors that affect the rate of UHS. The main factors, as shown by the results of the study, are functional status, and the availability of social resources and of community care services.

The sustainability of health systems is strongly related to hospital care costs, which are one of the most important components of the health budget. The cost of hospitalization of the elderly continues to increase despite the gradual reduction of the total number of hospital admissions in elderly people.[21,34,35] To reduce the cost (i.e. reduce the number of hospital beds devoted to acute hospital care) without affecting negatively the quality of care, interventions should target the factors related to the highest hospitalization rate, especially among robust older adults, who make up the largest percentage of the use of health services and resources, and among adults on the border of frailty (FS around 40). These factors, as underlined by the results of the study, are mainly connected to determinants other than the diseases affecting the patients. In fact, an integrated programme developed at community level, focused on counteracting the impact of social factors and slowing the functional decline, is able to reduce both hospitalization and the mortality rate.[36,37]

The main study limitation is related to the extension of these results to other settings in Europe: the Lazio region has a low rate of both hospital and out-of-hospital services associated with a growing level of monetary support to families with a non–self-sufficient component.[30–32,38] This pattern is different from that experienced in many Northern or Eastern European, while it is similar to that in some Southern European ones. Moreover, the relatively small number of frail individuals identified in the sample could have led to some volatility in the analysis, even if we are quite confident that statistical power of the study and the multivariate analyses have allowed independent assessment of the impact of each variable on the outcomes.

The assessment of frailty could represent a key point in developing primary care services so as to provide an effective intervention capable of improving older citizens' quality of life and reducing UHS, this being an important factor in increasing the sustainability of health systems in Europe. Screening should always target the population at increased risk for the condition being screened: the results of the study can support the idea to implement a systematic screening of frailty addressing the general over-74 citizens older adult population carried out at local/regional level by multidimensional tools. It could be the first step of personalized pathways that include access to effective prevention services able to slow or postpone functional decline and counteract social isolation.[37,39,40] At a population level, the information stemming from the assessment of frailty could provide the framework to plan effective care services, addressing the care needs of older adults. This approach could also offer a chance to deal with inequalities of care offered to older adults in the European countries.

Acknowledgements

Special thanks to IPASVI Centre of Excellence, Health Local Units Roma 2, Roma 5, Roma 6, Viterbo, Frosinone and Department of Epidemiology Lazio Regional Health Service for the collaboration. The article was revised by Dr. Michael Bennett, an English native medical doctor.

Supplementary data

Supplementary data are available at *EURPUB* online.

Funding

The study was funded partially by IPASVI.

Conflicts of interest: None declared.

Key points

- Frailty is a strong predictor of the mortality in the short term.
- Multidimensional frailty is a strong predictor of survival in the short term as well as in the medium-long term.
- The demand for hospital care is associated with socio-economic resources, functional status and community care more than it is to specific diseases.
- The association between frailty and hospitalization over a short time of observation is weaker than that seen between frailty and mortality.
- The highest hospitalization rate is in the pre-frail older population.

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