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Urinary and double incontinence in older women with hip fracture - risk of death and predictors of incident symptoms among survivors in a 1-year prospective cohort study

Aino T. Hellman-Bronstein [a,*], Tiina H. Luukkaala [b,c], Seija S. Ala-Nissilä [d,e], Minna A. Kujala [a,f], Maria S. Nuotio [a,f,g,h]

[a] Division of Geriatric Medicine, Department of Clinical Medicine, University of Turku, Turku, Finland
[b] Research, Development and Innovation Center, Tampere University Hospital, Tampere, Finland
[c] Health Sciences, Faculty of Social Sciences, Tampere University, Tampere, Finland
[d] Department of Obstetrics and Gynecology, Turku University Hospital, Turku, Finland
[e] Department of Clinical Medicine, University of Turku, Turku, Finland
[f] Department of Geriatric Medicine, Seinäjoki Central Hospital, Seinäjoki, Finland
[g] Research Services and Department of Clinical Medicine, Turku University Hospital, Turku, Finland
[h] Welfare Division, City of Turku, Turku, Finland

A R T I C L E I N F O

Keywords:
Urinary incontinence
Double incontinence
Hip fracture
Frailty
Mortality

A B S T R A C T

Objectives: To investigate the association of urinary incontinence (UI) and double incontinence (DI, concurrent UI and fecal incontinence) with one-year mortality among older female hip fracture patients and to identify predictors of incident UI and DI.
Design: A prospective cohort study
Setting and subjects: 1,468 female patients aged ≥ 65 treated for their first hip fracture during the period 2007–2019
Methods: Continence status was elicited at baseline and one-year post-fracture. Age- and multivariable-adjusted Cox proportional hazards and multinomial logistic regression models were used to determine the associations of incontinence with one-year mortality and to examine the associations of baseline predictors with incident UI and DI respectively.
Results: Of the women with no incontinence, UI and DI, 78 (13%), 159 (23%) and 60 (34%), died during follow-up. UI (HR 1.72, 95% CI 1.31–2.26) and DI (HR 2.61, 95% CI 1.86–3.66) were associated with mortality after adjusting for age. These associations lost their predictive power in multivariable analysis while age over 90, living in an institution, impaired mobility, poor nutrition, polypharmacy, and late removal of urinary catheter remained associated with mortality. Of continent women, 128 (21%) developed UI and 23 (4%) DI during follow-up. In multivariable analysis, impaired mobility was associated with incident UI (OR 2.56, 95% CI 1.48–4.44) and DI (OR 4.82, 95% CI 1.70–13.7), as well as living in an institution (OR 3.44, 95% CI 1.56–7.61 and OR 3.90, 95% CI 1.17–13.0).
Conclusions and Implications: Underlying vulnerability likely explains differences in mortality between continence groups and development of incident UI and DI.

Funding sources: This work was supported by the Medical Research Fund of the Hospital District of Southern Ostrobothnia and the State Research Financing of Seinäjoki Central Hospital (grant numbers VTR111 and VTR233).Brief summary: Urinary and double incontinence are likely to represent the level of frailty in older women with hip fracture. It is important to screen for incontinence during hospitalization after a hip fracture and target CGA on these patients to improve their prognosis. Maintaining physical function is the main determinant for maintaining continence in older women after a hip fracture.

* Corresponding author.
E-mail address: athell@utu.fi (A.T. Hellman-Bronstein).

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List of Abbreviations

UI	urinary incontinence
DI	double incontinence
FI	fecal incontinence
UC	urinary cathether
CGA	comprehensive geriatric assessment
MCI	mild cognitive impairment
LTCF	long-term care facility
ASA	The preoperative American Society of Anesthesiologists

1. Introduction

Urinary incontinence (UI), defined as any involuntary loss of urine (Ancona, Hamid & Schizas, 2019), is a common geriatric syndrome and associated with numerous poor outcomes. UI is more common among women than among men and its prevalence increases with advancing age. Nearly 40% of women older than 60 years and 80% of women residing in long-term care have UI. (Gibson & Wagg, 2014; Lukacz, Santiago-Lastra, Albo & Brubaker, 2017). The factors leading to the development of UI in an older adult are complex and not exclusive to incontinence but also to other geriatric syndromes, such as falls (Chong, Chan, Lim & Ding, 2018). Indeed, older individuals with UI are from 1.5 to 2.3 times more likely to fall than are individuals without urinary symptoms (Gibson, Hunter & Camicioli, 2018). Hip fracture, one the most serious consequences of a fall, is a common injury among older women with well-established consequences of increased mortality, morbidity, and costs (Guzon-Illescas, Perez Fernandez & Crespí Villarias, 2019; Pajulammi, Luukkaala, Pihlajamäki & Nuotio, 2016). Up to 45% of women with hip fracture suffer from UI (Hellman-Bronstein, Luukkaala, Ala-Nissilä, Kujala & Nuotio, 2022).

UI has been associated with increased mortality in community-living older adults (John, Bardini, Combescure & Dällenbach, 2016), as well as after a hip fracture (Guzon-Illescas et al., 2019). There is increasing data suggesting that the underlying cause for this connection is frailty (Berardelli, de Rango & Morelli, 2013; Matta, Hird & Saskin, 2020; Nakanishi, Tatara, Shinsho, Murakami & Takatorige, 1999; Nuotio, Luukkaala, Tammela & Jylhä, 2009). Frailty is defined as a state of increased vulnerability to outer stressors resulting from diminished physiological reserves and function (Fried, Tangen & Walston, 2001). This multidimensional syndrome carries an increased risk for multiple adverse outcomes, such as institutionalization and death (Fried et al., 2001; Suskind, 2017; Veronese, Soysal & Stubbs, 2018).

Double incontinence (DI), defined as concurrent UI and fecal incontinence (FI) (Sultan, Monga & Lee, 2017), is also more common in women and associated with advancing age. It is a severe manifestation of pelvic floor dysfunction and associated with functional, physical, and cognitive deficits. According to earlier studies, prevalence of DI has ranged between 2.5 and 14.5% in community-dwelling older individuals (Matthews, 2014, 2013; Wu, Matthews, Vaughan & Markland, 2015), 33–65% in patients residing in long term care (Bliss, Gurvich, Eberly & Harms, 2018; Musa et al., 2019), and 8% in older women with hip fracture (Hellman-Bronstein et al., 2022). Individuals with DI have been found to be an especially frail group among general older populations (Stenzelius, Mattiasson, Hallberg & Westergren, 2004) and among older women with hip fracture (Hellman-Bronstein et al., 2022).

The literature on incident UI, and especially on DI, remains scarce. In one study, hospital-acquired incontinence affected one in five women suffering a hip fracture (Palmer, Baumgarten, Langenberg & Carson, 2002). Advancing age, cognitive impairment, physical disability, and frailty have been reported as predictors of UI and FI among hospitalized older adults (Chong et al., 2018; Mecocci, von Strauss & Cherubini, 2005).

Since older women frequently suffer from both incontinence and a hip fracture, we find it important to evaluate the prognostic significance of UI and DI for older women with hip fracture and to find predictors of incident UI and DI one-year post-fracture.

2. Methods

2.1. Study population

Prospective data were collected on 1675 consecutive women aged 65 and over who were treated for their first hip fracture in Seinäjoki Central Hospital, Finland, between September 2007 and January 2019. The only exclusion criteria during data collection were pathologic and periprosthetic fractures. All patients, regardless of cognitive or functional state or living arrangements, were invited to participate.

Pre-fracture continence status was reported by 1486 women. After exclusion of the few patients with FI only ($n = 18$), the final sample of our study was 1468 women, as presented in Fig. 1.

Seinäjoki Central Hospital is the only hospital providing acute surgical care in the region of the Hospital District of Southern Ostrobothnia, which has a catchment area of around 200,000 residents. The patients were discharged postoperatively into primary care hospitals for rehabilitation after a median length of stay of five days (interquartile range [IQR] of 2–8 days) in the central hospital.

2.2. Data collection and variables

The baseline data were collected during hospitalization by a trained geriatric nurse interviewing the patients or their representatives, and from the patient medical records. In addition, a follow-up interview was conducted one-year post-fracture, generally by the same nurse. The study was approved by the Ethics Committee of the Hospital District of Southern Ostrobothnia.

Data on continence status before the fracture was collected during the initial perioperative interview. Given the potentially high number of disabled and cognitively impaired respondents in the study population, a simple single-answer (yes or no) question was preferred to using more detailed questionnaires. Continence status at one-year follow-up was elicited in a similar way in a telephone interview. UI was defined as any reported involuntary loss of urine and FI as any reported involuntary loss of feces respectively. Patients with both UI and FI were deemed to have DI. Data on age, number of prescribed medications, diagnosis of cognitive disorder (yes or no), mobility, and living arrangements were collected. The diagnosis of cognitive disorder - as made by a geriatrician or a neurologist according to our national guidelines (Suhonen et al., 2011) - was ascertained from the patient medical records. Mild cognitive impairment (MCI) was not included among the diagnoses. Independent mobility was defined as being able to ambulate independently without assistance. As with continence status, a survey-like questions were used instead of standardized measures for mobility. However, the questions to define mobility were modified from the original dataset of the British National Hip Fracture Database (National Hip Fracture Database, 2022). Living in an institution was defined as residing in a primary care hospital or a long-term care facility (LTCF) providing 24-h care. The data on the aforementioned factors were updated in the one-year follow-up interview. Fracture type, ASA score and removal or non-removal of urine catheter (UC) before discharge from the central hospital were extracted from the medical records. The dates of death for the mortality analyses were provided by the National Population Register centre and extracted from the patient medical records. There were no losses to the mortality follow-up.

The preoperative American Society of Anesthesiologists (ASA) risk scores were used to assess general health at baseline. There are five classes: (1) healthy person, (2) mild systemic disease, (3) severe systemic disease, (4) severe systemic disease that is a constant threat of life, and (5) a moribund person who is not expected to survive without surgery (Sankar, Johnson, Beattie, Tait & Wijeysundera, 2014). Nutritional status was assessed using the Mini Nutritional Assessment Short Form (MNA-SF) (Rubenstein, Harker, Salvà, Guigoz & Vellas, 2001)

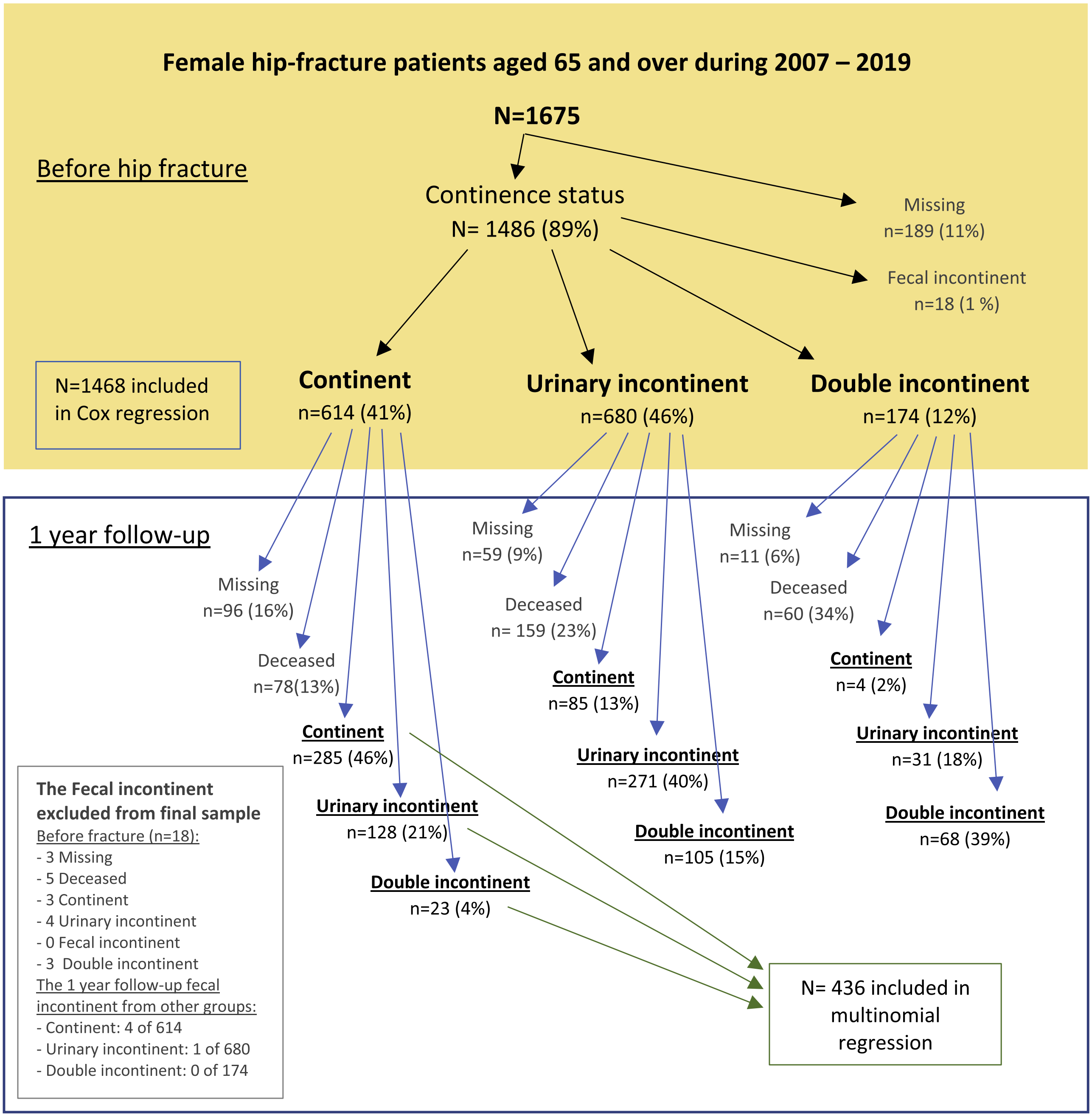

Fig. 1. A flowchart of continence status in the study population.

during hospitalization. For the purposes of our study, poor nutrition was defined as being at risk for malnutrition or being malnourished according to the MNA-SF. The MNA-SF also served as a proxy for frailty, since our study was lacking a more specific frailty measure (Soysal et al., 2019). Categorization of the baseline variables is shown in Table 1.

2.3. Statistical analysis

Age- and multivariable-adjusted Cox proportional hazard regression analyses with hazard ratios (HR) and 95% confidence intervals (CI) were conducted to examine associations of UI and DI and other baseline variables with mortality. Assumptions of Cox regression proportional hazard analysis were tested and met. Age- and multivariable-adjusted multinomial regression analyses were also conducted to examine predictors of incident UI or DI one-year post-fracture. IBM SPSS Statistics version 25.0 for Windows software (SPSS Inc. Chicago, Illinois) was used for statistical analyses. All tests were two-sided, and p values < 0.05 were considered statistically significant.

3. Results

A flowchart detailing the study population is presented in Fig. 1. Out of 1468 patients, 614 were continent, 680 had UI and 174 had DI at baseline. The mean age of the patients was 82.7 ± 6.8. At baseline, 30% of the patients were living in institutions and 30% had cognitive disorders, and 49% could not ambulate independently. After one year of follow up, 297 (20%) of the patients had died. The mortality rate was highest in the DI group (34%), and lowest in the continent group (13%). In the age-adjusted Cox proportional hazards model, UI (hazard ratio [HR] 1.72, 95% confidence interval [CI] 1.31–2.26) and DI (HR 2.61, 95%CI 1.86–3.66) were associated with one-year mortality, as well as all the other baseline variables except for fracture type (Table 1).

Table 1
Distribution of the baseline indicators between alive and deceased individuals ($N = 1468$) after 1 year follow-up. Age-and multivariable-adjusted survival with hazard ratios (HR) and 95% confidence intervals (CI) were calculated using Cox regression.

	N	One-year survival Deceased $n = 297$		Alive $n = 1171$		Age-adjusted		Multivariable-adjusted	
		n	(%)	n	(%)	HR	(95% CI)	HR	(95% CI)
Age									
65–79	376	36	(12)	340	(29)	1.00		1.00	
80–89	770	141	(48)	629	(54)	2.04	(1.41–2.94)	1.33	(0.91–1.93)
≥ 90	322	120	(40)	202	(17)	4.72	(3.25–6.86)	2.32	(1.57–3.44)
Fracture type*									
Intracapsular	883	164	(55)	719	(61)	1.00		1.00	
Extracapsular	583	133	(45)	450	(38)	1.07	(0.85–1.35)	0.95	(0.75–1.21)
ASA									
1–2	196	10	(3)	186	(16)	1.00		1.00	
3–5	1248	281	(95)	967	(83)	3.61	(1.91–6.82)	1.82	(0.94–3.50)
Not known	24	6	(2)	18	(2)	4.16	(1.51–11.5)	2.53	(0.90–7.08)
Number of regularly taken medications									
< 4	246	17	(6)	229	(20)	1.00		1.00	
4–10	925	184	(62)	741	(63)	2.79	(1.70–4.59)	1.98	(1.18–3.32)
> 10	297	96	(32)	201	(17)	4.79	(2.86–8.04)	2.64	(1.53–4.53)
Diagnosis of cognitive disorder									
No	1030	181	(61)	849	(73)	1.00		1.00	
Yes	436	115	(39)	321	(27)	1.46	(1.16–1.85)	0.78	(0.60–1.01)
Mobility*									
Independent	786	65	(22)	681	(58)	1.00		1.00	
Non-independent	719	232	(78)	487	(42)	3.49	(2.63–4.64)	2.13	(1.52–2.97)
Living arrangements*									
Home	1023	143	(48)	880	(75)	1.00		1.00	
Institution	441	154	(52)	287	(25)	2.34	(1.85–2.96)	1.36	(1.04–1.77)
MNA-SF before hip fracture									
Normal (12–14)	583	59	(20)	524	(45)	1.00		1.00	
Poor nutrition (< 12)	614	197	(66)	417	(36)	3.25	(2.43–4.35)	2.09	(1.52–2.86)
Not known	271	41	(14)	230	(20)	1.52	(1.02–2.26)	1.01	(0.66–1.54)
Removal of urine catheter									
During hospital stay	813	122	(41)	691	(59)	1.00		1.00	
Later	631	160	(54)	471	(40)	1.70	(1.34–2.15)	1.58	(1.23–2.02)
Not known	24	15	(5)	9	(1)	8.56	(4.99–14.7)	8.18	(4.68–14.3)
Continence before fracture									
Continent	614	78	(26)	536	(46)	1.00		1.00	
Urinary incontinent	680	159	(54)	521	(45)	1.72	(1.31–2.26)	1.15	(0.86–1.54)
Double incontinent	174	60	(20)	114	(10)	2.61	(1.86–3.66)	1.19	(0.82–1.74)

ASA, American Society of Anesthesiologists -risk score; MNA-SF, Mini Nutritional Assessment Short Form. *Small numbers of missing values ($n = 1–4$) were not shown in table.

The associations of UI and DI lost their predictive power in the multivariable adjusted analysis while age over 90 (HR 2.32; 95% CI 1.57–3.44), living in an institution (HR 1.36, 95% CI 1.04–1.77), impaired mobility (HR 2.13, 95% CI 1.52–2.97), poor nutrition (HR 2.09, 95% CI 1.52–2.86), having 4–10 (HR 1.98, 95% CI 1.18–3.32) or over 10 medications (HR 2.64, 95% CI 1.53–4.53), and late removal of UC (HR 1.58, 95% CI 1.23–2.02) continued to be associated with one-year mortality (Table 1).

Of continent women, 128 (21%) developed UI and 23 (4%) DI during follow-up. In the age-adjusted analyses, both incident UI and DI at follow-up were associated with the following baseline variables: age between 80 and 89, age over 90, diagnosis of cognitive disorder, non-independent mobility, living in an institution, and late removal of UC, the odds ratios being stronger for DI. Poor nutrition was also associated with incident UI, but not with DI (Table 2).

In the multivariable model, only non-independent mobility (odds ratio [OR] 2.56, 95% CI 1.48–4.44) and living in an institution (OR 3.44, 95% CI 1.56–7.61) remained independently associated with incident UI at one-year follow-up. The corresponding results for DI at one-year follow up were the same with stronger odds ratios: non-independent mobility (OR 4.82, 95% CI 1.70–13.7) and living in an institution (OR 3.90, 95% CI 1.17–13.0) (Table 3).

4. Discussion

Our study demonstrates a clear difference in rates of mortality among the different continence groups, mortality being highest in patients with DI and lowest in continent women with hip fracture. Our principal finding is that incontinence itself is not associated with mortality and several factors denoting disability and suggesting frailty are likely to explain the association with mortality. In a recent cross-sectional study of over 2000 community-dwelling older patients, UI was associated with increased risk of mortality after adjusting for demographics, but the association lost its significance after adjusting for a 45-item frailty index, indicating that underlying frailty explained the difference in mortality (Matta et al., 2020). Similar results have also been reported in longitudinal studies for UI and FI (Berardelli et al., 2013; Nakanishi et al., 1999; Nuotio et al., 2009).

The relationship between incontinence and frailty is likely bidirectional: cumulative complications of incontinence may lead to frailty, and conversely advancing frailty combined with outer stressors may result in incontinence (Chong et al., 2018; Suskind, 2017). UI has been found to be twice as common among frail older adults than among the robust, and the underlying causes of incontinence in these patients are diverse and related to functional decline (Veronese et al., 2018). It must be noted however, that no standardized measures for frailty were available in the present study and this has to be born in mind when interpreting our results. Nevertheless, in our earlier study, both UI and DI in older women with hip fracture were associated with measures of functional disability and other factors related to frailty in an outpatient comprehensive geriatric assessment (CGA) carried out 4–6 months post-hip fracture. Patients with DI were demonstrated to be an especially vulnerable group

Table 2
Age-adjusted associations of the baseline indicators with urinary or double incontinence after 1 year follow-up among continent hip fracture patients at baseline ($N = 614$) were analyzed using multinomial regression. Reference group was no incontinence at 1 year follow-up ($n = 285$).

	Urinary incontinent ($N = 128$) Age-adjusted					Double incontinent ($N = 23$) Age-adjusted				
	n	(%)	OR	(95% CI)	p	n	(%)	OR	(95% CI)	p
Age										
65–79	27	(21)	1.00			2	(9)	1.00		
80–89	75	(59)	2.34	(1.42–3.88)	<0.001	14	(61)	5.91	(1.32–26.5)	0.020
≥ 90	26	(20)	4.58	(2.30–9.14)	<0.001	7	(30)	16.7	(3.27–85.0)	<0.001
Fracture type										
Intracapsular	78	(61)	1.00			12	(52)	1.00		
Extracapsular	50	(39)	1.15	(0.73–1.79)	0.550	11	(48)	1.53	(0.64–3.65)	0.344
ASA*										
1–2	21	(16)	1.00			2	(9)	1.00		
3–5	106	(83)	1.43	(0.82–2.52)	0.211	20	(87)	2.23	(0.49–10.1)	0.299
Number of regularly taken medications										
< 4	29	(23)	1.00			4	(17)	1.00		
4–10	86	(67)	1.41	(0.84–2.34)	0.191	13	(57)	1.45	(0.45–4.67)	0.533
> 10	13	(10)	0.91	(0.42–1.97)	0.812	6	(26)	2.95	(0.77–11.4)	0.116
Diagnosis of cognitive disorder										
No	98	(77)	1.00			16	(70)	1.00		
Yes	30	(23)	2.33	(1.30–4.15)	0.004	7	(30)	3.06	(1.13–8.26)	0.028
Mobility										
Independent	74	(58)	1.00			8	(35)	1.00		
Non-independent	54	(42)	3.39	(2.04–5.62)	<0.001	15	(65)	7.37	(2.82–19.2)	<0.001
Living arrangements										
Home	102	(80)	1.00			16	(70)	1.00		
Institution	26	(20)	4.57	(2.18–9.59)	<0.001	7	(30)	6.67	(2.22–20.0)	<0.001
MNA-SF before hip fracture										
Normal (12–14)	61	(48)	1.00			8	(35)	1.00		
Poor nutrition (< 12)	46	(36)	1.84	(1.13–3.00)	0.014	9	(39)	2.49	(0.91–6.84)	0.077
Not known	21	(16)	2.02	(1.06–3.86)	0.033	6	(26)	4.10	(1.30–13.0)	0.016
Removal of urine catheter*										
During hospital stay	74	(58)	1.00			11	(48)	1.00		
Later	53	(41)	1.79	(1.13–2.84)	0.013	12	(52)	2.44	(1.01–5.90)	0.048

Results are shown by odds ratios (OR) with 95% Confidence intervals (CI). Statistically significant ($p<0.05$) ORs are in **bold**. ASA, American Society of Anesthesiologists -risk score; MNA-SF, Mini Nutritional Assessment Short Form. *Missing values ($n = 1$–2) were not shown.

(Hellman-Bronstein et al., 2022).

Since frailty is thought to be at least partially a reversible condition (Suskind, 2017), a multidisciplinary treatment approach aimed at improving the mobility and the nutrition of these patients might improve their overall prognosis. Since our study had a recruitment time of over a decade, several advances in orthogeriatric management were made during this period in Seinäjoki Central Hospital, including shortening the delay from admission to surgery, faster removal of urinary catheter during hospitalization, and more patients receiving CGA (Pajulammi, Pihlajamäki, Luukkaala, Jousmäki & Nuotio, 2017). In our earlier study, receiving CGA during hospitalization after a hip fracture was associated with improved prognosis one-month post-fracture in older women aged 80–89 (Pajulammi et al., 2017). In a Cochrane review, CGA was also found to reduce 4–6-month and one-year mortality among hip fracture patients (Eamer, Taheri & Chen, 2018). Incontinence seems to serve as a useful marker for disability and potentially underlying frailty in these patients, and special attention needs to be directed to the rehabilitation of hip fracture patients with incontinence.

Most of the predictors of mortality that remained significant in the multivariable analysis of the present study have been established in both our own and other researchers' studies, usually including both men and women. Taking between four and ten regular medications was independently associated with nearly a two-fold risk of death compared to those taking fewer than four medications, and the risk was nearly threefold in patients taking over 10 regular medications. This association has been established before in general older populations (Fried et al., 2014; Li, Zhang & Yang, 2022), as well as after a hip fracture (Pajulammi et al., 2016). The use of multiple medications, usually defined as more than five, is called polypharmacy. Polypharmacy has been shown to be associated with multiple adverse outcomes, such as falls, hospitalization, and mortality. Patients taking multiple medications usually have multiple comorbidities and tend to be in poorer health than those taking fewer, thus, polypharmacy is likely a marker for underlying health issues (Fried et al., 2014). Polypharmacy also increases the likelihood of side effects of drugs, drug-drug interactions, and inappropriate prescribing (Fried et al., 2014; Li et al., 2022; Pajulammi et al., 2016).

In accordance with previous observations (Guzon-Illescas et al., 2019; Hu, Jiang, Shen, Tang & Wang, 2012), older age, living in a LTCF, and non-independent mobility were predictors of higher mortality in our study, all of which suggest the significance of underlying disability in our patients.

Poor nutrition was an independent prognostic factor in the present study, which concurs with an earlier study concerning malnutrition and mortality among hip fracture patients (Helminen, Luukkaala, Saarnio & Nuotio, 2017a). Approximately 40% of the patients had poor nutrition at the time of the fracture. In a significant proportion of the patients, the nutritional status tends to deteriorate with time after fracture (Hellman-Bronstein et al., 2022; Helminen, Luukkaala, Saarnio & Nuotio, 2017b). A connection between malnutrition, impaired mobility, and strength has been demonstrated among older hip fracture patients, suggesting a connection between protein-energy malnutrition and sarcopenia (Helminen et al., 2017). High prevalence of malnutrition probably also reflects a high rate of frailty in our study population, since MNA-SF tool has also been introduced as a screening tool for frailty with a similar cut-off value (Soysal et al., 2019).

Late removal of UC was independently associated with mortality, which is in accordance with earlier studies. Older women and surgical patients have been shown to be at the highest risk for inappropriate UC use and thus, for adverse outcomes including poorer recovery and death. Conversely, prompt removal of UC has been demonstrated to protect the patient from functional and physical decline and thus potentially decrease the risk of institutionalization and mortality after a hip fracture

Table 3
Multivariable-adjusted associations of baseline indicators of urinary and double incontinence after 1 year follow-up among continent hip fracture patients at baseline ($N = 614$) were analyzed using multinomial logistic regression. Reference group for both was no incontinence at follow-up ($n = 285$).

	Urinary incontinent ($n = 128$) Multivariable-adjusted					Double incontinent ($n = 23$) Multivariable-adjusted				
	n	(%)	OR	(95% CI)	p	n	(%)	OR	(95% CI)	p
Age										
65–79	27	(21)	1.00			2	(9)	1.00		
80–89	75	(59)	1.42	(0.81–2.50)	0.224	14	(61)	2.52	(0.51–12.5)	0.258
≥ 90	26	(20)	2.13	(0.96–4.70)	0.062	7	(30)	4.51	(0.71–28.5)	0.109
Fracture type										
Intracapsular	78	(61)	1.00			12	(52)	1.00		
Extracapsular	50	(39)	1.07	(0.66–1.73)	0.776	11	(48)	1.44	(0.56–3.74)	0.450
ASA*										
1–2	21	(16)	1.00			2	(9)	1.00		
3–5	106	(83)	1.11	(0.59–2.09)	0.171	20	(87)	1.13	(0.21–6.10)	0.885
Number of regularly taken medications										
< 4	29	(23)	1.00			4	(17)	1.00		
4–10	86	(67)	1.01	(0.57–1.79)	0.961	13	(57)	0.80	(0.22–2.94)	0.736
> 10	13	(10)	0.55	(0.23–1.30)	0.175	6	(26)	1.24	(0.27–5.69)	0.782
Diagnosis of cognitive disorder										
No	98	(77)	1.00			16	(70)	1.00		
Yes	30	(23)	1.55	(0.81–2.96)	0.183	7	(30)	2.00	(0.66–6.04)	0.221
Mobility										
Independent	74	(58)	1.00			8	(35)	1.00		
Non-independent	54	(42)	**2.56**	**(1.48–4.44)**	**0.001**	15	(65)	**4.82**	**(1.70–13.7)**	**0.003**
Living arrangements										
Home	102	(80)	1.00			16	(70)	1.00		
Institution	26	(20)	**3.44**	**(1.56–7.61)**	**0.002**	7	(30)	**3.90**	**(1.17–13.0)**	**0.026**
MNA-SF before hip fracture										
Normal (12–14)	61	(48)	1.00			8	(35)	1.00		
Poor nutrition (< 12)	46	(36)	1.38	(0.81–2.36)	0.234	9	(39)	1.54	(0.52–4.60)	0.438
Not known	21	(16)	1.46	(0.72–2.98)	0.297	6	(26)	2.40	(0.66–8.76)	0.184
Removal of urine catheter*										
During hospital stay	74	(58)	1.00			11	(48)	1.00		
Later	53	(41)	1.41	(0.85–2.33)	0.187	12	(52)	1.71	(0.65–4.54)	0.281

Results are shown by odds ratios (OR) with 95% Confidence intervals (CI). Statistically significant ($p < 0.05$) ORs are in **bold**. ASA, American Society of Anesthesiologists -risk score; MNA-SF, Mini Nutritional Assessment Short Form. *Missing values ($n = 1–2$) were not shown.

(Gould, Umscheid & Agarwal, 2010; Morri, Chiari & Forni, 2018; Pajulammi et al., 2016; Pajulammi, Pihlajamäki, Luukkaala & Nuotio, 2015; Sørbye & Grue, 2013; Wen, Chi, Chang, Huey & Ming, 2015; Zisberg, Gary, Gur-yaish & Admi, 2011).

One in five women who were continent at baseline developed UI during follow-up, and 4% developed DI. In the age-adjusted analysis, advancing age, diagnosis of cognitive disorder, and late removal of UC were associated with both incident UI and DI, and poor nutrition with UI, but they lost their predictive power in the multivariable analysis. Cognitive impairment, advancing age, and physical disability have previously been identified as risk factors for hospital-acquired UI and FI (Mecocci et al., 2005). Advancing age and cognitive disorders are well established risk factors of both UI and DI (Bliss et al., 2018; Gibson, Johnson & Kirschner-Hermanns, 2021; Stenzelius et al., 2004; Wu et al., 2015). At baseline, nearly one in three of our patients had a known cognitive disorder. Our earlier study demonstrated that 23% of older hip fracture patients develop a cognitive disorder during two-year follow-up post-fracture (Jaatinen, Luukkaala, Viitanen & Nuotio, 2020), meaning that over half of our patients had a clinical or emerging cognitive disorder at the time of the fracture. Given the high level of vulnerability in our study population, cognitive disorder may have an impact on the development of incontinence in our patients.

We know from the literature that prolonged use of UC during hospitalization predicts incident UI and worse recovery after a hip fracture. Use of UC inhibits free movement, interferes with normal voiding strategies, and predisposes the patient to infections and other complications, all of which may lead to the development of incontinence (Morri et al., 2018; Zisberg et al., 2011). International guidelines recommend removing the UC of surgical patients within 24 h postoperatively and avoiding the routine use of UC altogether, when possible, to minimize adverse effects (Gould et al., 2010).

As stated before, malnutrition is extremely common among hip fracture patients and associated with impaired strength and mobility, as well as with mortality of these patients. Protein-energy malnutrition leads to sarcopenia, which in turn, by decrease in both muscle mass and strength of the pelvic floor muscles as well as over-all muscle strength and function, may lead to functional decline and increased dependency of the patient, ultimately resulting in the development of incontinence (Erdogan et al., 2019; Sieber, 2019).

Continent patients with non-independent ambulation before fracture where nearly three times more likely to develop UI and nearly five times more likely to develop DI during follow-up than those who could ambulate independently. Similarly, patients living in a LTCF had a three-fold risk of developing UI and a four-fold risk of developing DI compared to those living at home at the time of the fracture. In a study on older women with hip fracture, 21% of the patients developed incontinence during hospitalization, and non-independent mobility, living in a LTCF before the fracture, and confusion where predictors of incident incontinence (Palmer et al., 2002). Frailty has been shown to predict incident UI in older adults up to one year following hospitalization (Chong et al., 2018). Prevalence of UI, DI, and hip fractures are known to be highest in individuals living in LTCFs (Bliss et al., 2018; Gibson & Wagg, 2014; Hu et al., 2012; Lukacz et al., 2017; Musa et al., 2019). In a study on incident DI in patients living in LTCFs, older age, functional and cognitive decline, and comorbidities were risk factors of incident DI (Bliss et al., 2018). These results highlight the importance of maintaining physical function for retaining continence in an older adult. Indeed, physical activity has been observed to protect older women against incident UI (Bauer, Kenfield & Sorensen, 2021).

To the best of our knowledge, this is the first study to examine the association of both UI and DI with mortality, as well as predictors of incident UI and DI in a large real-world cohort of older women with hip fracture. Our data collection was also done systematically and almost entirely by one individual and there were no losses in mortality follow-up. Additionally, our research population is very representative of this patient group, since patients living in an LTCF or having a cognitive disorder were not excluded from the study.

We acknowledge several limitations to our study. Firstly, incontinence symptoms were evaluated only with simple questions during interviews instead of validated questionnaire, and frequency, severity or timeframe of the symptoms were not included in the data collection. This was done mainly because we wanted to keep the collection of the follow-up data simple given the vulnerable and potentially cognitively impaired patient population. Secondly, screening or assessment tools specifically designed for the detection of frailty were not used. The main reason for this was the early onset of data collection and the lack of these items in the original database. We did not find it reasonable or feasible to add them retrospectively. Nevertheless, functional disability is known to be related with frailty and MNA-SF measure, which was systemically used in our study, has been previously validated for the detection of fraily (Soysal et al., 2019). Thirdly, comorbidities were not recorded in detail, and possible pre-existing urogynecological disorders were not known. Only ASA score represents the general health of the patient. Fourthly, due to the relatively long period of data collection, there could be secular changes in the patient population and in the care they have received, which may have affected the results of the present study. Fifthly, given the relatively small sample size of the DI group, some caution is due when interpreting our results. Finally, there is a possibility of both selection and survivor bias, as every fifth patient died during the follow-up and rates of incontinence and disability are expected to be high in these patients. Similarly, those in poorest health among survivors were most likely to drop-out during follow-up period, resulting in lower rates of incident UI, and especially DI. Therefore, these figures must be interpreted with some caution.

4.1. Conclusions and implications

UI and DI are likely to represent the level of vulnerability in older women with hip fracture. It is important to screen for incontinence during hospitalization after a hip fracture and target CGA on these patients to improve their prognosis. Maintaining physical function is the main determinant for maintaining continence in older women after a hip fracture.

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CRediT authorship contribution statement

Aino T. Hellman-Bronstein: Conceptualization, Formal analysis, Writing – original draft, Writing – review & editing. **Tiina H. Luukkaala:** Conceptualization, Formal analysis, Writing – review & editing. **Seija S. Ala-Nissilä:** Conceptualization, Formal analysis, Writing – review & editing. **Minna A. Kujala:** Funding acquisition, Writing – review & editing. **Maria S. Nuotio:** Conceptualization, Funding acquisition, Formal analysis, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare no conflicts of interest.

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