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IS MALNUTRITION A RISK FACTOR FOR INCIDENT URINARY TRACT INFECTION AMONG OLDER PEOPLE IN RESIDENTIAL CARE FACILITIES?

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Abstract: *Background:* Malnutrition and urinary tract infections (UTI) are common among older people living in residential care facilities. *Objectives:* To determine whether malnutrition is a risk factor for incident urinary tract infection in people aged ≥65 years living in residential care facilities. *Design, Setting, and Participants:* A prospective cohort study of people living in residential care facilities in northern Sweden (N=373). Data from the Frail Older People-Activity and Nutrition and Umeå Dementia and Exercise studies were used. *Measurements:* Malnutrition was assessed using the Mini Nutritional Assessment (MNA). Risk factors for UTI were explored using univariate and multivariate Cox proportional hazard regression analyses. Maximum follow-up time was 9 months. *Results:* The incidence of UTI was 460/1000 person-years; 85/276=30.8% of women and 16/97=16.5% of men contracted UTIs. History of UTI (hazard ratio [HR] 2.804, 95% confidence interval [CI] 1.824–4.311), heart failure (HR 2.101, 95% CI 1.368–3.225), hypertension (HR 1.656, 95% CI 1.095–2.504), and low Mini-Mental State Examination (MMSE) score (HR 0.937, 95% CI 0.892–0.985) were associated independently with higher risk of incident UTI in multivariate analyses. Malnutrition was not associated with UTI in the whole sample or in women; MNA score was associated with UTI in men in univariate analysis (HR 0.841, 95% CI 0.750–0.944). *Conclusion:* The incidence of UTI was high in residential care facilities and individuals with histories of UTI, heart failure, hypertension, or cognitive impairment were more likely to be affected. Malnutrition was not a risk factor for UTI in the whole sample or in women, but may constitute a risk for UTI among men.

Key words: Malnutrition, urinary tract infection, residential care, older people.

Introduction

Malnutrition is very common in older people (1, 2), especially among people in residential care facilities (3–5). It negatively affects physical and cognitive function, muscle mass, and cardiac output, and increases the risks of pressure ulcers, falls, institutionalization, and mortality (6, 7). Furthermore, malnutrition reduces the immune response, leading to an increased risk of infection (4, 6, 8–10). Malnutrition has been suggested to be among the most important risk factors for infection among older people (4), who generally have higher rates of infection due to physiological changes associated with aging (11–13). Older people in residential care facilities are especially susceptible to infection due to factors such as chronic disease, certain medications, cognitive decline, functional impairment, and the use of invasive devices, including urinary catheters, which may predispose them to infection (14).

Urinary tract infection (UTI) is the most common infection in residential care facilities (5, 11, 13, 15). In a Swedish study of older people living in such facilities, the annual incidence of UTI was 45% (3). More women than men are affected by UTIs (16), but the incidence of UTI in men increases with age and with the level of functional impairment (17), and for older men living in residential care facilities the difference in prevalence between men and women is less pronounced (18, 19). UTI in older people is associated with worse functional status and a higher morbidity rate (4, 15, 20); it is also a source of sepsis and death (21).

A previous study of older people identified unintentional loss of faeces, history of UTI, functional decline, level of education, and severe cognitive impairment as predictors of UTI in univariate analysis of people living in long-term care facilities (22). Diabetes mellitus has also been found to be a risk factor for UTI among older people (23, 24). It has previously been reported a cross-sectional association between a history of UTI in the previous year and a lower Mini Nutritional Assessment (MNA) score in a sample of older people that included many individuals living in residential care facilities (3, 25). To our knowledge, the most recent study to investigate whether malnutrition increases the risk of UTI among older people living in residential care facilities is a study from 1988 that included 97 participants (26). The aim of this study was to investigate whether malnutrition is a risk factor for incident UTI in a population of older people living in residential care facilities.

Methods

This prospective cohort study included data from the Frail Older People-Activity and Nutrition (FOPANU) (27) and

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Umeå Dementia and Exercise (UMDEX) (28) randomized controlled trials, which have been described in detail elsewhere. These studies involved 3- and 4-month social and physical activity interventions, respectively. In the FOPANU study, participants were also randomized to receive a protein-enriched supplement or placebo beverage. In both studies, people living in residential care facilities in Umeå, northern Sweden (N=1351), were screened for participation. Those aged ≥65 years with Mini-Mental State Examination (MMSE) scores ≥10 (29) who were dependent in personal activities of daily living (P-ADL), according to the Katz index (30), could stand up from a chair with armrests with help from no more than one person, and had physician approval to participate were included. In addition, participants in the UMDEX study were diagnosed with dementia, able to hear speech in a usual speaking voice from a distance of 1 m, and understood instructions in Swedish. Participants provided informed oral consent; when cognitive impairment was suspected or confirmed (including all UMDEX study participants), next-of kin were also asked to provide consent. The FOPANU and UMDEX studies were approved by the Ethics Committee of the Medical Faculty of Umeå University (§391/01) and the Regional Ethics Review Board of Umeå (2011-205-31M), respectively. Participants with documented MNA scores were selected for the present study. The final sample comprised 373 participants. During the maximum follow-up period of 9 months, 44 participants died and 15 participants withdrew from the study for other reasons. Figure 1 illustrates the sample selection process. No individual participated in both studies.

Malnutrition was assessed using the MNA, a validated and widely used tool for nutritional screening in older people. It comprises 18 questions; scores were classified as indicating malnutrition (<17), risk of malnutrition (17–23.5), and good nutritional status (24–30) (1, 31). Body mass index (BMI) was calculated as weight (in kilograms) divided by height (in meters) squared (32). The level of dependence in P-ADL was assessed using the Barthel index; the maximum score of 20 indicates independence in P-ADL (33, 34). The Berg Balance Scale (BBS) was used to assess balance, with scores ranging from 0 to 56 and lower scores indicating poorer balance (35). The MMSE was used to assess cognitive function, with scores ≤17 indicating severe cognitive impairment (29). The 15-item Geriatric Depression Scale was used to assess depressive symptoms. Scores of 5–9 were considered to indicate mild depression and scores of 10–15 were considered to indicate moderate or severe depression (36).

At baseline assessment, measurements, diagnoses, and medication use were registered. After the interventions, the incidence of UTI was ascertained systematically. Nurses working at the residential care facilities collected data on diagnoses, clinical characteristics, and prescribed drugs from participants' medical records in the FOPANU study; in the UMDEX study, physicians reviewed medical records. In both studies, an experienced geriatrician evaluated diagnoses, drug treatments, and assessment scores to make final diagnoses. Depressive disorder and dementia were diagnosed according to the criteria of the Diagnostic and Statistical Manual of Mental Disorders IV, Text Revision (37). The measure of incident UTI was based on clinical UTI diagnoses made by treating physicians. The physicians based the diagnoses on clinical symptoms, and used laboratory tests, urinary dipstick tests and/or bacterial cultures as diagnostic tool. In examining the occurrence of UTI in the previous year, we included participants with UTI at baseline, as a large proportion (26/33) of these individuals also had documented UTI in the previous year.

Statistical Analysis

SPSS software (version 22.0; IBM, Armonk, NY, USA) was used for statistical analysis. P values <0.05 were considered to be statistically significant. Chi-squared tests and independent-samples t-tests were used to compare people who had had and who had not had a UTI. Variables with p values <0.15 in these analyses were entered into Cox proportional hazard regression analyses to explore risk factors for UTI. Gynecological disease was excluded from analyses of the whole sample, but included in analysis of the subsample of women. Variables significantly associated with UTI ($p<0.05$) in the univariate Cox proportional hazard regression analyses were examined for correlation before inclusion in further analyses. This process led to the exclusion of the incontinence variable, measured by the Barthel index, from multivariate Cox proportional hazard regression analyses; no other variable violated the proportional hazard assumption (Corr<0.4). The model was adjusted according to whether participants had been enrolled in a social or physical activity intervention and whether they had received a protein-enriched supplement during the intervention. Separate analyses for women and men and analyses excluding those with UTI at baseline were also conducted using the same procedure as for analyses of the whole sample.

Results

The mean age of study participants was 84.9±6.8 years and 276 (74%) participants were women. The mean MNA score did not differ between women and men (20.8±3.2 vs. 20.8±3.4, p=0.899). Eleven percent of participants were malnourished and 72% were at risk of malnourishment, according to MNA scores (Table 1).

Out of the 373 participants, 101 persons overall (27.1%), 85 of women (85/276=30.8%) and 16 of men (16/97=16.5%) contracted at least one UTI during the 9-month follow-up period. The incidence rate of UTI was 460 UTIs per 1000 person-years. Fifteen of 33 (45.5%) participants with baseline UTI had at least one UTI during follow up, compared with 86 of 340 (25.3%) persons with no UTI at baseline (p=0.013). Significantly more women than men had a UTI diagnosed in the previous year (43.8% vs. 30.9%, p=0.026).

Table 1
Characteristics of the sample with and without urinary tract infection (UTI) during the 9- month follow-up period

	Total (N=373)	UTI (n=101)	No UTI (n=272)	p
Women	276 (74.0)	85 (84.2)	191 (70.2)	0.006
Age (years)	84.9±6.8	85.6±6.7	84.6±6.8	0.203
Assessments				
BMI	26.2±5.1	26.4±4.9	26.1±5.2	0.598
GDS-15	4.1±3.2	4.0±3.1	4.1±3.2	0.672
MMSE	16.3±4.6	15.2±4.0	16.7±4.8	0.005
BBS	27.9±14.7	28.4±14.8	26.3±14.3	0.224
P-ADL	12.0±4.4	11.2±4.1	12.3±4.5	0.028
MNA, mean	20.8±3.2	20.4±3.4	20.9±3.2	0.208
MNA				
0–17	41 (11.0)	13 (12.9)	28 (10.3)	
17–23.5	270 (72.4)	77 (76.2)	193 (71.0)	
24–30	62 (16.6)	11 (10.9)	51 (18.8)	
Drugs				
Number of drugs	8.7±4.2	9.4±4.5	8.5±4.0	0.053
Analgesics, excl. ASA	220 (59.0)	59 (58.4)	161 (59.2)	0.892
SSRI	150 (40.2)	45 (44.6)	105 (38.6)	0.298
Benzodiazepines	114 (30.6)	25 (24.8)	89 (32.7)	0.138
Diuretics	181 (48.5)	53 (52.5)	128 (47.1)	0.352
Laxatives	202 (54.2)	57 (56.4)	145 (53.3)	0.590
Diagnoses				
Angina	100 (26.8)	28 (27.7)	72 (26.5)	0.808
Arthritis	105 (28.2)	36 (35.6)	69 (25.4)	0.050
Atrial fibrillation	68 (18.2)	17 (16.8)	51 (18.8)	0.670
Constipation, prev. month	223 (59.8)	65 (64.4)	158 (58.1)	0.273
Chronic lung disease	67 (18.0)	17 (16.8)	50 (18.4)	0.729
Dementia	285 (76.4)	82 (81.2)	203 (74.6)	0.185
Depressive disorder	220 (59.0)	60 (59.4)	160 (58.8)	0.919
Diabetes mellitus	65 (17.4)	15 (14.9)	50 (18.4)	0.424
Diarrhea, prev. month	31 (8.3)	6 (5.9)	25 (9.2)	0.312
Gastric ulcer	50 (13.4)	16 (15.8)	34 (12.5)	0.400
Gynecologic dis. (n=276)	24 (6.4)	11 (10.9)	13 (4.8)	0.033
Heart attack, prev. year	8 (2.1)	3 (3.0)	5 (1.8)	0.502
Heart failure	107 (28.7)	41 (40.6)	66 (24.3)	0.002
Hypertension	180 (48.3)	61 (60.4)	119 (43.8)	0.004
Malignancy, prev. 5 years	42 (11.3)	12 (11.9)	30 (11.0)	0.817
Osteoporosis	114 (30.6)	34 (33.7)	80 (29.4)	0.428
Other infection, prev. year	85 (22.8)	24 (23.8)	61 (22.4)	0.785
Pace maker	25 (6.7)	7 (6.9)	18 (6.6)	0.914
Pneumonia, prev. year	35 (9.4)	17 (16.8)	18 (6.6)	0.003
Prostate disease (n=97)	40 (10.7)	10 (9.9)	30 (11.0)	0.754
Sleeping disorder	145 (38.9)	35 (34.7)	110 (40.4)	0.308
Stroke	109 (29.2)	31 (30.7)	78 (28.7)	0.704
Urinary catheter	24 (6.4)	10 (9.9)	14 (5.1)	0.096
Urinary incontinence*	127 (34.0)	45 (44.6)	82 (30.1)	0.009
Urinary retention	13 (3.5)	4 (4.0)	9 (3.3)	0.760
UTI, prev. year	151 (40.5)	66 (65.3)	85 (31.3)	<0.001

Values are presented as n (%) or as mean±SD. BMI= body mass index; GDS= Geriatric Depression Scale; MMSE= Mini-Mental State Examination; BBS= Berg Balance Scale; P-ADL=personal activities of daily living; MNA= Mini Nutritional Assessment; ASA= acetyl-salicylic acid. SSRI = selective serotonin reuptake inhibitor. * According to item in Barthel index.

Table 2
Risk factors for urinary tract infection (UTI) in univariate analyses

	Whole sample (N=373) (UTI n=101)			Women (n=276) (UTI n=85)			Men (n=97) (UTI n=16)		
	HR	**95% CI**	**p**	**HR**	**95% CI**	**p**	**HR**	**95% CI**	**p**
Sex	2.036	1.194–3.474	0.009						
MMSE	0.931	0.889–0.975	0.002	0.921	0.873–0.972	0.003			
P-ADL	0.948	0.910–0.988	0.011	0.950	0.907–0.994	0.027			
Urinary incontinence*	1.775	1.199–2.629	0.004	1.873	1.218–2.881	0.004			
Number of drugs	1.053	1.005–1.103	0.029				1.141	1.015–1.282	0.027
Benzodiazepines	0.719	0.458–1.130	0.153	0.656	0.398–1.084	0.100			
Arthritis	1.458	0.971–2.192	0.069	1.616	1.039–2.514	0.033			
Heart failure	2.010	1.351–2.992	0.001	1.880	1.208–2.926	0.005	3.769	1.368–10.383	0.010
Hypertension	1.853	1.244–2.762	0.002	1.493	0.969–2.301	0.069	4.028	1.398–11.608	0.010
Urinary catheter	1.591	0.828–3.056	0.164				5.151	1.933–13.729	0.001
Pneumonia, prev. year	2.365	1.403–3.986	0.001	2.035	1.127–3.676	0.019	4.398	1.408–13.736	0.011
UTI, prev. year	3.235	2.146–4.876	<0.001	2.923	1.866–4.579	<0.001	4.059	1.474–11.175	0.007
Gynecologic disease				1.742	0.924–3.284	0.086			
MNA score							0.841	0.750–0.944	0.003
Atrial fibrillation							0.229	0.030–1.733	0.153
Prostate disease							2.455	0.892–6.757	0.082
Stroke							2.277	0.855–6.067	0.100
Urinary retention							3.166	1.021–9.819	0.046

Cox proportional hazard regression analyses of potential risk factors for UTI. Variables associated with UTI (p-value <0.15) in chi-squared or independent-samples t-tests were added to the analyses. The dependent variable was UTI during the 9-month follow-up period. HR= hazard ratio; CI= confidence interval; MMSE= Mini-Mental State Examination; P-ADL= personal activities of daily living. MNA= Mini Nutritional Assessment. * According to item in Barthel index.

The mean MNA score did not differ between participants with and without incident UTI (20.4±3.4 vs. 20.9±3.2, p=0.208; Table 1). However, MNA scores were significantly lower among those with a history of UTI in the previous year than among those with no such history (20.0±3.4 vs. 21.3±3.1, p<0.001). Additionally, during the 9-month follow-up period, 17.7% of participants with MNA scores ≥24 and 28.9% of those with MNA scores <24 contracted a UTI (p=0.070).

In univariate Cox proportional hazard regression analyses, female sex, low MMSE score, dependence in P-ADL, urinary incontinence, number of prescribed drugs, heart failure, hypertension, pneumonia in the previous year, and UTI in the previous year were risk factors for incident UTI during follow up (Table 2). History of UTI in the previous year, heart failure, hypertension, and low MMSE score were associated independently with higher risk of incident UTI in multivariate Cox proportional hazard regression analyses (Table 3). Exclusion of participants with baseline UTI (n=33) and adjustment for intervention activity type and protein supplement consumption did not alter the results (data not shown).

Table 3
Risk factors for urinary tract infection (UTI) in multivariate analysis of the whole sample

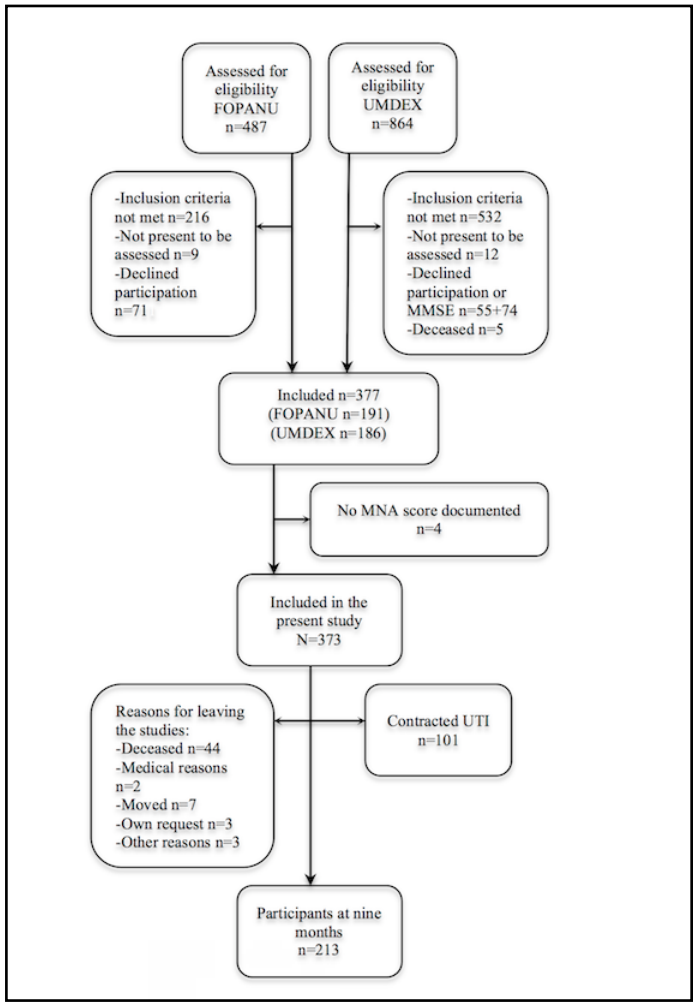
	HR	**95% CI**	**p**
UTI, prev. year	2.804	1.824–4.311	<0.001
Heart failure	2.101	1.368–3.225	0.001
Sex	1.670	0.972–2.872	0.063
Hypertension	1.656	1.095–2.504	0.017
Pneumonia, prev. year	1.459	0.836–2.547	0.184
Number of drugs	0.994	0.939–1.051	0.827
P-ADL	0.989	0.945–1.036	0.642
MMSE	0.937	0.892–0.985	0.011

Cox proportional hazard regression analysis. Variables significantly associated (p<0.05) with UTI in univariate Cox proportional hazard regression analyses were added to the multivariate analysis. Urinary incontinence was correlated with P-ADL and was excluded. The dependent variable was UTI during the 9-month follow-up period. HR= hazard ratio; CI= confidence interval; P-ADL= personal activities of daily living; MMSE= Mini-Mental State Examination.

In separate analyses of women, low MMSE score, dependence in P-ADL, urinary incontinence, arthritis, heart failure, pneumonia in the previous year, and UTI in the previous year were associated significantly with incident UTI

(Table 2). For men, the number of prescribed drugs, heart failure, hypertension, urinary catheter use, pneumonia in the previous year, UTI in the previous year, and urinary retention were associated significantly with incident UTI. Also, a higher MNA score was associated with a lower risk of incident UTI for men, but not for women (Table 2).

Figure 1
Flow chart of the study population



Discussion

This study revealed a high incidence of UTI among older people living in residential care facilities. Malnutrition was not a risk factor for UTI in the whole sample or in women, but it seemed to be associated with UTI development in men in univariate analyses. History of UTI in the previous year, heart failure, hypertension, and low MMSE score were associated independently with incident UTI during the 9-month follow-up period. Although UTI was more common among women than among men, sex was not an independent risk factor for UTI.

The high incidence of UTI in the present study (460/1000 person-years or 1.3/1000 person-days) is in agreement with previous studies of older people living in residential care facilities (3, 38).

Malnutrition was not associated with the incidence of UTI in the present study, similar to the results of a study published in 1988. The study in question also investigated residential care facilities, however, malnutrition was assessed by blood albumin level, their sample only included 97 participants, and the age of participants ranged widely from 21 to 94 years (26). Malnutrition has been suggested to be an important risk factor for pneumonia and skin and soft-tissue infection, two other extremely common infections in older people (39–41). Furthermore, other authors have suggested that malnutrition is a risk factor for nosocomial infection (8, 42) and that malnutrition among people living in residential care facilities is associated with serious infection and/or death (43). However, for older people in residential care facilities, malnutrition does not appear to be a risk factor for UTI generally. However, in men, a low MNA score seemed to be associated with an increased risk of UTI in univariate analyses. Both malnutrition and the ageing process itself reduce the immune function and additionally older people tend to have fewer symptoms of infection (4). This might make it more difficult to diagnose symptomatic UTI in older people, as in the present study. However, despite this, a small but non-significant difference in MNA-scores was found between those who contracted an UTI and those who did not. Therefore, larger studies are needed to explore this possible association.

This study showed an association between history of UTI and low MNA score, as reported previously among people living in residential care facilities and very old community-dwelling women (3, 25). A possible explanation for this finding is that infection increases the risk that a person will become malnourished because of greater metabolic demand (4, 10). History of UTI was also a strong risk factor for UTI contraction, and individuals with UTI at baseline contracted another UTI more often than did those with no baseline UTI. These results are also in line with those published previously (22, 44).

Heart failure and hypertension were associated independently with incident UTI. Heart failure has previously been found to be a risk factor for UTI in older trauma patients (45). In addition, people with heart failure often have multiple non-cardiac (46) and cardiac (47) comorbidities (including hypertension). This factor may partly explain the associations of UTI with heart failure and hypertension in our sample. The number of prescribed drugs was also associated with incident UTI in univariate analyses; this number increases with age and disease burden (48). Several medications are also associated with adverse effects that increase the risk of infection (5, 14). Furthermore, polypharmacy is associated with an increased risk of urinary incontinence (49, 50), which in turn is associated with UTI (51, 52).

Low MMSE score was associated with incident UTI in the present study. A previous study found that low MMSE score

was a risk factor for UTI contraction among older people (22). Cognitive impairment may increase the risk of infection by affecting a person's ability to maintain personal hygiene (53). This factor may also explain our finding that dependence in P-ADL was associated with UTI. Individuals with cognitive decline can have difficulty communicating symptoms (11), and urinary sample collection can be problematic (53), which may render UTI diagnosis in these individuals difficult (54). The authors of a previous study suggested that the difficulty in communicating symptoms could lead to the underestimation of UTI in older people with dementia (38).

Surprisingly, female sex was not an independent risk factor for UTI. Although a large proportion of women in our sample contracted UTIs other factors than sex appear to contribute to UTI susceptibility. Furthermore, UTI risk factors differed partially between women and men, perhaps due to sex-based differences in the pathophysiology of this infection. Prostatic hypertrophy has been suggested to be among the most important factors predisposing men to UTI (18), which may explain the observed association of related variables – urinary retention and urinary catheter use – with UTI in men, but not in women. Urinary incontinence was associated with UTI in women, but not in men, in univariate analyses. The variable was excluded from the multivariate analysis of the whole sample because of correlation with the P-ADL variable. Urinary incontinence affects many older women in nursing homes (55) and has been associated with UTI previously (25, 52).

Study strengths and limitations

This study involved a large and well-defined sample of older people living in residential care facilities in Sweden, a large proportion of whom had dementia. All participants were assessed comprehensively and the sample was well defined regarding P-ADL and cognition. The inclusion of people with cognitive decline and/or dementia requires careful consideration, and next-of-kin were asked to give consent when cognitive impairment was suspected or confirmed in both studies.

Given that this was part of larger randomized controlled trials the exercise and nutritional interventions may have affected participants' nutritional status. However, adjustment for intervention type and protein-enriched supplement receipt during the intervention did not change the results. Only 11% of participants were malnourished, although the sample comprised only people living in residential care facilities, the majority of whom were diagnosed with dementia. Furthermore, only 16 of 97 men contracted UTIs. These factors limited our ability to analyze malnutrition as a risk factor for infection.

The incidence of UTI has been reported to decrease with administration of intravaginal estriol to postmenopausal women with recurrent UTIs (56). Unfortunately, available information about estrogen supplementation in this sample did not specify whether administration was oral or vaginal; this variable was thus not analyzed in the present study.

Conclusion

The incidence of UTI was high among older people living in residential care facilities and individuals with histories of UTI, heart failure, hypertension, or cognitive impairment were more likely to be affected. Those with histories of UTI the previous year had a lower mean MNA score but malnutrition was not an independent risk factor for incident UTI in the whole sample or in women, but may constitute a risk for UTI among men. Identifying risk factors may contribute to the prevention of UTI and this is greatly needed, especially as UTI negatively affects social life and physical and psychological health (57).

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Ethical standards: The FOPANU study was approved by the Ethics Committee of the Medical Faculty of Umeå University (§391/01) and the UMDEX study was approved by the Regional Ethics Review Board of Umeå (2011-205-31M).

Conflict of interest: The authors declare no conflict of interest.

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