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Association between osteoarthritis and urinary tract infection in older adults

A nationwide population-based cohort study

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Abstract

Osteoarthritis (OA) may increase urinary tract infection (UTI) in older adults. However, this issue remains unclear. We identified 8599 older patients (≥65 years) with OA, and an equal number of older patients without OA, matched by age, sex, and index date from the Taiwan National Health Insurance Research Database between 2001 and 2005. Past histories, including UTI and underlying comorbidities, were included in the analyses. Comparisons for any UTI, ≥1 hospitalization for UTI, and ≥3 hospitalizations for UTI between the 2 cohorts by following up until 2015 were performed. In both cohorts, the percentages of age subgroups were 65–74 years (65.7%), 75–84 years (30.1%), and ≥85 years (4.2%). The male sex was 42.4%. Patients with OA had an increased risk of any UTI compared with those without OA after adjusting for all past histories (adjusted hazard ratio [AHR]: 1.72; 95% confidence interval [CI]: 1.64–1.80). Compared with patients without OA, patients with OA also had an increased risk of ≥1 hospitalization for UTI and ≥3 hospitalizations for UTI (AHR: 1.13; 95% CI: 1.06–1.19 and AHR: 1.25; 95% CI: 1.13–1.38, respectively). In addition to OA, age 75–84 years, female sex, history of UTI, benign prostatic hyperplasia, indwelling urinary catheter, cerebrovascular disease, dementia, and urolithiasis were independent predictors for any UTI. This study showed that OA was associated with UTI in older adults. We suggest appropriately managing OA and controlling underlying comorbidities to prevent subsequent UTI.

Abbreviations: AHR = adjusted hazard ratio, BPH = benign prostatic hyperplasia, CI = confidence interval, ICD-9-CM = International Classification of Diseases, Ninth Revision, Clinical Modification, LHID = Longitudinal Health Insurance Database, NHIRD = National Health Insurance Research Database, OA = osteoarthritis, UTI = urinary tract infection.

Keywords: hospitalization, older adult, osteoarthritis, urinary tract infection

1. Introduction

The aging population is an important worldwide issue. In the United States, the older population (≥65 years) is projected to grow from 49 million to 95 million between 2020 and 2060.[1] In Taiwan, older adults were 14% of the total population in 2018, and are projected to be 20% in 2025.[2] The percentage of very old adults (≥85 years) in the older population will increase from 10.3% to 27.4% between 2020 and 2070.[2] Urinary tract infections (UTIs) are responsible for 15.5% of hospitalizations and 6.2% of deaths attributable to infectious diseases in older adults.[3] In institutionalized adults, UTIs

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Data are available from the National Health Insurance Research Database (NHIRD) published by Taiwan National Health Insurance Bureau. Due to legal restrictions imposed by the government of Taiwan in relation to the "Personal Information Protection Act," data cannot be made publicly available. Requests for data can be sent as a formal proposal to the NHIRD (http://nhird.nhri.org.tw).

This study was approved by the institutional review board of the Chi Mei Medical Center and conducted according to the Helsinki declaration. Informed consent from the patients was waived because this study is retrospective and contains de-identified information, which does not affect the rights and welfare of the patients.

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are the most common infections.[4,5] Recurrent UTIs in older adults increases morbidity, mortality, and personal and social burdens.[6]

Osteoarthritis (OA) is the most common joint disease and one of the most frequent causes of pain and disability.[7] OA was found in many older adults, and nearly 80% of older people aged over 75 years.[7] In the United States, OA is the second cause of work disability in men over 50 years of age.[7] OA of the knee and hip can affect walking, climbing stairs, and self-care, and eventually result in decreased quality of life.[8,9] Because of pain and decreased physical activity, OA is associated with higher healthcare usage and increased risks of obesity, depression, cardiovascular disease, renal disease, and diabetes.[10] A previous study reported that decreased physical activity might increase UTI.[11] However, we did not find any study about the association between OA and UTI in older adults by searching using the keywords "older adult," "osteoarthritis," and "urinary tract infection" in PubMed and Google Scholar. Therefore, we conducted the present study to investigate this issue. We hypothesized that UTI might increase in older adults with OA.

2. Methods

2.1. Data source

This nationwide population-based cohort study was conducted using the Longitudinal Health Insurance Database 2000 (LHID 2000), which is a data subset from Taiwan's National Health Insurance Research Database (NHIRD).[12] The National Health Insurance system of Taiwan covers >99.6% of the Taiwanese population, and the claims data of this system are released as the NHIRD.[12,13] The LHID 2000 contains 2,000,000 individuals randomly sampled from the NHIRD using random number generators.[12] The distribution of age and sex are not different between patients in the LHID 2000 and those in the NHIRD.[12]

2.2. Study design, setting, and participants

We identified older patients (≥65 years) with OA between 2001 and 2005 as the study cohort and an equal number of older patients without OA by matching age, sex, and index date as the comparison cohort. The date of diagnosis of OA for the first time in the study cohort was defined as the index date. The diagnosis of OA was defined when the patient had the diagnosis of International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) of 715 or 721, and at least 1 hospitalization or 3 outpatient clinic visits. Underlying comorbidities and potential risk factors for UTI.[14,15] including a history of UTI, benign prostatic hyperplasia (BPH), an indwelling urinary catheter, cerebrovascular disease, diabetes, dementia, and urolithiasis were included in the analyses.

2.3. Definitions of variables

The age subgroups were classified as 65 to 74, 75 to 84, and ≥85 years.[16–19] We defined the underlying comorbidities as follows: a history of UTI (ICD-9-CM 590, 595, 597, 599.0, 601), BPH (ICD-9-CM 600), indwelling urinary catheter (ICD-9-CM Vol. 3 Procedure Codes 57.94), cerebrovascular disease (ICD-9-CM 430-438), diabetes (ICD-9-CM 250), dementia (ICD-9-CM 290, 294.1, 294.2, 331), and urolithiasis (ICD-9-CM 592, 594). Patients who have been diagnosed with the above-listed diseases, hospitalized at least once, or had 3 outpatient clinic visits before index date were defined as having the diseases.

2.4. Outcome measurements

We compared the risks of any UTI (ICD-9-CM 590, 595, 597, 599.0, 601) (≥1 outpatient clinic visit, emergency department visit, or hospitalization for UTI), ≥1 hospitalization for UTI, and ≥3 hospitalizations for UTI between the 2 cohorts through following up the development of UTI, death, or the end of 2015.

2.5. Ethical statements

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board at Chi Mei Medical Center. Although informed consent was waived while using NHIRD data, all datasets are anonymized to protect individuals' confidentiality. Personal identity, birth date, and names are encrypted, and this de-identification process was approved by an independent third-party organization.[20] The waiver does not affect the rights and welfare of the participants.

2.6. Statistical analysis

We used SAS 9.4 for Windows (SAS Institute, Cary, NC) for all statistical analyses. Pearson chi-square tests were used for categorical variables. The older population with high mortality might biased the estimates of UTI incidence derived from Kaplan-Meier survival function (Figure 1, Supplemental Digital Content, http://links.lww.com/MD/H17). Therefore, the subdistribution hazard function, introduced by Fine and Gray was used to compare the risks of any UTI, ≥1 hospitalization for UTI, and ≥3 hospitalizations for UTI between the 2 cohorts.[21] We set the significance level at $P < .05$ (two-tailed).

3. Results

A total of 8599 patients with OA and 8599 patients without OA were identified for the present study (Table 1). In both cohorts, individuals aged 65 to 74 years comprised the largest age subgroup (65.7%), followed by 75 to 84 years (30.1%), and ≥85 years (4.2%). The male percentage was 42.4%. Compared with patients without OA, patients with OA had a higher prevalence of past histories of UTI, BPH, an indwelling urinary catheter, cerebrovascular disease, and urolithiasis, but a lower prevalence of dementia. There was no significant difference in diabetes between the 2 cohorts.

Patients with OA had an increased risk of any UTI than those without OA after adjusting for a history of UTI, BPH,

Table 1

Comparison of demographic characteristics between older patients with and without OA.

Variables	With OA, n = 8599	Without OA, n = 8599	*P* value
Age subgroup			
65–74 y (%)	5649 (65.7)	5649 (65.7)	>.999
75–84 y (%)	2590 (30.1)	2590 (30.1)	
≥85 y (%)	360 (4.2)	360 (4.2)	
Sex			
Male	3642 (42.4)	3642 (42.4)	>.999
Female	4957 (57.7)	4957 (57.7)	
History			
UTI	468 (5.4)	362 (4.2)	<.001
BPH	635 (7.4)	360 (4.2)	<.001
Indwelling urinary catheter	1752 (20.4)	936 (10.9)	<.001
Cerebrovascular disease	801 (9.32)	797 (9.27)	.916
Diabetes	1290 (15.0)	1337 (15.6)	.319
Dementia	118 (1.4)	189 (2.2)	<.001
Urolithiasis	103 (1.2)	63 (0.7)	<.001
Mortality	4168 (48.5)	5589 (65.0)	<.001
Any UTI at follow-up	5947 (69.2)	4773 (55.5)	<.001

Data are presented as number (percentage) or mean ± SD.

BPH = benign prostatic hyperplasia, OA = osteoarthritis, SD = standard deviation, UTI = urinary tract infection.

an indwelling urinary catheter, cerebrovascular disease, diabetes, dementia, and urolithiasis (adjusted hazard ratio [AHR]: 1.72; 95% confidence interval [CI]: 1.64–1.80) (Table 2). The increased risk was also found in the stratified analyses, including age subgroups, sex, past histories of UTI, BPH, indwelling urinary catheter, cerebrovascular disease, and diabetes. The increased risk of any UTI was most prominent in the age subgroup of ≥85 years (AHR: 2.59; 95% CI: 2.00–3.36).

In the comparison of ≥1 hospitalization for UTI and ≥3 hospitalizations for UTI, patients with OA had an increased risk than those without OA (AHR: 1.13; 95% CI: 1.06–1.19 and AHR: 1.25; 95% CI: 1.13–1.38, respectively) (Tables 3 and 4). In the age subgroup of 65 to 74, the differences in risk of ≥1 hospitalization for UTI and ≥3 hospitalizations for UTI were not significant between the 2 cohorts. Compared with other age subgroups, aged ≥85 years had the most prominent risk of ≥1 hospitalization for UTI (AHR: 1.62; 95% CI: 1.25–2.10) and ≥3 hospitalizations for UTI (AHR: 2.37; 95% CI: 1.47–3.82).

In addition to OA, other independent predictors for any UTI in all older patients were age 75 to 84 years (AHR: 1.05; 95% CI: 1.00–1.10), female sex (AHR: 1.54; 95% CI: 1.47–1.61), a past history of UTI (AHR: 1.44; 95% CI: 1.31–1.59), BPH (AHR: 1.11; 95% CI: 1.05–1.18), an indwelling urinary catheter (AHR: 1.29; 95% CI: 1.20–1.40), cerebrovascular disease (AHR: 1.23; 95% CI: 1.16–1.31), dementia (AHR: 1.39; 95% CI: 1.11–1.74), and urolithiasis (AHR: 1.44; 95% CI: 1.31–1.59) (Table 5).

4. Discussion

The present study showed that OA was associated with an increased risk of subsequent UTI in older patients. The impact of OA on subsequent UTI was most prominent in the age subgroup of ≥85 years. In addition to OA, age 75 to 84 years, female sex, a history of UTI, BPH, an indwelling urinary catheter, cerebrovascular disease, dementia, and urolithiasis were also independent predictors for any UTI.

A possible explanation for UTI's increased risk is that patients with OA have decreased physical activity and even immobilization due to pain. This reduced activity predisposes them to inferior body function, sarcopenia and frailty, diabetes, and immune deficiencies related to UTI.[10,15,22–24] A study by Rosemann et al reported that patients with OA of the lower limb had decreased physical activity than those without OA.[22] Another study by Hirata et al found that >40% of women with hip OA were physically inactive and lacked moderate-intensity activity.[25] A national study by Zhu et al reported that a greater number of bedridden days was an independent risk factor for UTI.[26] A study by Shang et al about patients in home health care reported that limited physical function status was a risk factor for infections, including UTI.[27] In contrast to decreased physical activity, a large cohort study by Roger et al reported that avoiding immobilization and an ability to walk were associated with a 69% lower hospitalization rate for UTI in older adults admitted to a skilled nursing facility.[15] Even in residents with severe mobility problems, including being in a wheelchair or having a missing limb, maintaining or improving mobility (in bed or when transferring) could reduce the risk of hospitalization for UTI by 38% to 80%.[15]

A decrease in physical activity may cause the inability to urinate frequently, urinary retention, and urolithiasis, and then increase UTI risk.[15,26] Decreased physical activity may decrease the abdominal organs' pressure on the urinary bladder and decrease the urge to urinate, even when the bladder is full.[28] The bone will turnover to create hypercalciuria, and urine will collect in the lower portions of the renal calyces when the body is immobilized or in the supine position, which increases the risk of renal calculi formation even further.[29] Physical inactivity is also a major contributing factor for sarcopenia, frailty, and adverse outcomes.[23,30] Sarcopenia and frailty are also associated with impaired bladder function, which may increase UTI risk.[31] Therefore, the impact of OA is broad. Also, many adverse outcomes associated with OA affect each other and result in a vicious circle.

Physical inactivity is not only a cause for many adverse outcomes but also a complication from multiple factors in the older adults, including natural process of aging and comorbidities. The most common comorbidities are cerebrovascular disease,[32] dementia,[33] and diabetes.[34,35] Microvascular and macrovascular complications of diabetes were major contributing factors for disability and mortality in the older people.[34,35]

The increased risk of UTI was more prominent in the age subgroup of 75 to 84 years. In addition to OA, the present study found that female sex, a history of UTI, BPH, an indwelling urinary catheter, cerebrovascular disease, dementia, and

Table 2

Comparison of the risk of any UTI between older patients with and without OA using competing risk survival analysis.

	With OA		Without OA				
Variable	**Mortality (%)**	**UTI (%)**	**Mortality (%)**	**UTI (%)**	**Crude HR (95% CI)**	**AHR (95% CI)***	***P* value†**
Overall analysis	1243 (14.5)	5947 (69.2)	2333 (27.1)	4773 (55.5)	1.86 (1.78–1.94)	1.72 (1.64–1.80)	<.001
Stratified analysis							
Age (y)							
65–74 (%)	589 (10.4)	3866 (68.4)	1295 (22.9)	3075 (54.4)	1.87 (1.78–1.98)	1.76 (1.66–1.85)	<.001
75–84 (%)	555 (21.4)	1826 (70.5)	871 (33.6)	1521 (58.7)	1.72 (1.59–1.87)	1.62 (1.49–1.76)	<.001
≥85 y (%)	99 (27.5)	255 (70.8)	167 (46.4)	177 (49.2)	2.77 (2.14–3.57)	2.59 (2.00–3.36)	<.001
Sex							
Male	688 (18.9)	2246 (61.7)	1214 (33.3)	1726 (47.4)	1.88 (1.75–2.02)	1.75 (1.63–1.88)	<.001
Female	555 (11.2)	3701 (74.7)	1119 (22.6)	3047 (61.5)	1.84 (1.74–1.94)	1.73 (1.63–1.83)	<.001
History							
UTI	21 (4.5)	431 (92.1)	0 (0.0)	362 (100.0)	–	–	–
BPH	84 (13.2)	482 (75.9)	77 (21.4)	266 (73.9)	1.76 (1.39–2.22)	1.47 (1.16–1.87)	.002
Indwelling urinary catheter	321 (18.3)	1269 (72.4)	288 (30.8)	602 (64.3)	2.05 (1.79–2.35)	1.92 (1.67–2.21)	<.001
Cerebrovascular disease	133 (16.6)	613 (76.5)	209 (26.2)	553 (69.4)	1.62 (1.40–1.87)	1.49 (1.28–1.73)	<.001
Diabetes	195 (15.1)	956 (74.1)	340 (25.4)	918 (68.7)	1.61 (1.44–1.79)	1.48 (1.32–1.66)	<.001
Dementia	28 (23.7)	84 (71.2)	47 (24.9)	139 (73.5)	1.22 (0.90–1.66)	1.11 (0.80–1.54)	.541
Urolithiasis	5 (4.9)	87 (84.5)	4 (6.4)	53 (84.1)	1.81 (1.09–3.00)	1.45 (0.86–2.47)	.168

*Adjusted for UTI, BPH, indwelling urinary catheter, cerebrovascular disease, diabetes, dementia, and urolithiasis.

†AHR.

AHR = adjusted subdistribution hazard ratio, BPH = benign prostatic hyperplasia, CI = confidence interval, HR = subdistribution hazard ratio, OA = osteoarthritis, UTI = urinary tract infection.

Table 3

Comparison of the risk of ≥1 hospitalization for UTI between older patients with and without OA using competing risk survival analysis.

	With OA		Without OA				
Variable	**Mortality (%)**	**UTI (%)**	**Mortality (%)**	**UTI (%)**	**Crude HR (95% CI)**	**AHR (95% CI)***	***P* value†**
Overall analysis	2241 (26.1)	2927 (34.0)	3440 (40.0)	2623 (30.5)	1.19 (1.13–1.26)	1.13 (1.06–1.19)	<.001
Stratified analysis							
Age (y)							
65–74 (%)	1134 (20.1)	1571 (27.8)	1915 (33.9)	1505 (26.6)	1.10 (1.03–1.19)	1.04 (0.97–1.13)	.253
75–84 (%)	944 (36.5)	1183 (45.7)	1302 (50.3)	998 (38.5)	1.24 (1.13–1.35)	1.21 (1.10–1.32)	<.001
≥85 y (%)	163 (45.3)	173 (48.1)	223 (61.9)	120 (33.3)	1.67 (1.29–2.15)	1.62 (1.25–2.10)	<.001
Sex							
Male	1194 (32.8)	1013 (27.8)	1738 (47.7)	843 (23.2)	1.27 (1.16–1.40)	1.19 (1.08–1.31)	<.001
Female	1047 (21.1)	1914 (38.6)	1702 (34.3)	1780 (35.9)	1.14 (1.07–1.22)	1.11 (1.03–1.19)	.004
History							
UTI	113 (24.2)	212 (45.3)	127 (35.1)	197 (54.4)	0.86 (0.69–1.07)	0.87 (0.69–1.09)	.215
BPH	209 (32.9)	212 (33.4)	175 (48.6)	136 (37.8)	0.89 (0.71–1.12)	0.80 (0.63–1.02)	.075
Indwelling urinary catheter	562 (32.1)	778 (44.4)	419 (44.8)	425 (45.4)	1.39 (1.20–1.62)	1.41 (1.21–1.65)	<.001
Cerebrovascular disease	250 (31.2)	382 (47.7)	313 (39.3)	419 (52.6)	0.93 (0.80–1.07)	0.90 (0.77–1.05)	.189
Diabetes	380 (29.5)	596 (46.2)	548 (41.0)	632 (47.3)	1.02 (0.90–1.14)	0.99 (0.88–1.12)	.852
Dementia	46 (39.0)	61 (51.7)	65 (34.4)	118 (62.4)	0.74 (0.55–1.00)	0.70 (0.51–0.96)	.026
Urolithiasis	18 (17.5)	41 (39.8)	21 (33.3)	33 (52.4)	0.77 (0.47–1.28)	0.65 (0.37–1.17)	.151

*Adjusted for UTI, BPH, indwelling urinary catheter, cerebrovascular disease, diabetes, dementia, and urolithiasis.

†AHR.

AHR = adjusted subdistribution hazard ratio, BPH = benign prostatic hyperplasia, CI = confidence interval, HR = subdistribution hazard ratio, OA = osteoarthritis, UTI = urinary tract infection.

Table 4

Comparison of the risk of ≥3 hospitalizations for UTI between older patients with and without OA using competing risk survival analysis.

	With OA		Without OA				
Variable	**Mortality (%)**	**UTI (%)**	**Mortality (%)**	**UTI (%)**	**Crude HR (95% CI)**	**AHR (95% CI)***	***P* value†**
Overall analysis	3427 (39.9)	963 (11.2)	4835 (56.2)	854 (9.9)	1.29 (1.17–1.42)	1.25 (1.13–1.38)	<.001
Stratified analysis							
Age (y)							
65–74 (%)	1669 (29.6)	467 (8.3)	2621 (46.4)	471 (8.3)	1.11 (0.97–1.27)	1.07 (0.93–1.22)	.350
75–84 (%)	1494 (57.7)	434 (16.8)	1905 (73.6)	349 (13.5)	1.43 (1.23–1.66)	1.42 (1.22–1.65)	<.001
≥85 y (%)	264 (73.3)	62 (17.2)	309 (85.8)	34 (9.4)	2.46 (1.53–3.96)	2.37 (1.47–3.82)	<.001
Sex							
Male	1664 (45.7)	325 (8.9)	2211 (60.7)	252 (6.9)	1.42 (1.20–1.68)	1.34 (1.13–1.59)	<.001
Female	1763 (35.6)	638 (12.9)	2624 (52.9)	602 (12.1)	1.23 (1.09–1.38)	1.22 (1.08–1.37)	.001
History							
UTI	191 (40.8)	85 (18.2)	217 (59.9)	88 (24.3)	0.96 (0.69–1.34)	0.99 (1.71–1.38)	.939
BPH	307 (48.4)	70 (11.0)	252 (70.0)	42 (11.7)	1.13 (0.75–1.71)	1.06 (0.69–1.63)	.798
Indwelling urinary catheter	899 (51.3)	298 (17.0)	653 (69.8)	169 (18.1)	1.77 (1.38–2.27)	1.88 (1.46–2.42)	<.001
Cerebrovascular disease	399 (49.8)	165 (20.6)	512 (64.2)	196 (24.6)	1.03 (0.82–1.28)	1.02 (0.81–1.28)	.861
Diabetes	613 (47.5)	225 (17.4)	903 (67.5)	227 (17.0)	1.28 (1.05–1.56)	1.27 (1.04–1.55)	.019
Dementia	75 (63.6)	23 (19.5)	118 (62.4)	62 (32.8)	0.63 (0.39–1.03)	0.63 (0.38–1.02)	.062
Urolithiasis	34 (33.0)	15 (14.6)	33 (52.4)	16 (25.4)	0.81 (0.37–1.79)	0.62 (0.27–1.44)	.266

*Adjusted for UTI, BPH, indwelling urinary catheter, cerebrovascular disease, diabetes, dementia, and urolithiasis.

†AHR.

AHR = adjusted subdistribution hazard ratio, BPH = benign prostatic hyperplasia, CI = confidence interval, HR = subdistribution hazard ratio, OA = osteoarthritis, UTI = urinary tract infection.

urolithiasis were also independent predictors of UTI, which is compatible with previous studies.[14,15]

Overall, there are high percentages of developing "any UTI" in both OA (69.2%) and non-OA groups (55.5%) in the present study. A study recruiting 598 home care older patients (mean age: 81.9 years) in Taiwan reported that 47% (281 patients) had at least 1 UTI episode during 1 year of follow-up.[36] Another study in Taiwan reported that the risk of any UTI in the preceding year and in the preceding 5 years in the older women were 29.6% and 60%, respectively.[37] The present study has a longer follow-up period (15 years) than the studies above, and therefore the high percentages of "any UTI" may be reasonable.

This study showed that a higher mortality in patient with non-OA than in patients with OA, which is a conflicting issue in the literature.[38,39] In a large cohort study with 16 years' follow-up in Sweden, it revealed that the mortality between the OA group and non-OA group was not different.[38] Another large cohort study in England reported that patients with OA are at higher risks of death than the general population.[39] The possible explanations for the inconsistent results may be the treatments of OA, including medication, rehabilitation, weight loss therapy, and joint replacement surgery, affect the risks of subsequent morbidity and mortality.[40,41] Our study aimed to compare the risk of UTI between OA and non-OA, and therefore, the issue of mortality is beyond the scope of this study and warranted for further investigation in the future.

The percentages of mortality shown in the Tables 2 to 4 are different due to different outcome measurement and related end

Table 5

Independent predictors of any UTI in all older patients by the competing risk analysis.

Variable	Full model* AHR (95% CI)	*P* value
Cohort		
Without OA	1 (reference)	
With OA	1.72 (1.64–1.80)	<.001
Age (y)		
65–74	1 (reference)	
75–84	1.05 (1.00–1.10)	.041
≥85 y (%)	0.89 (0.79–1.01)	.074
Sex		
Female	1.54 (1.47–1.61)	<.001
Male	1 (reference)	
History		
UTI	1.44 (1.31–1.59)	<.001
BPH	1.11 (1.05–1.18)	<.001
Indwelling urinary catheter	1.29 (1.20–1.40)	<.001
Cerebrovascular disease	1.23 (1.16–1.31)	<.001
Diabetes	1.17 (0.98–1.39)	.082
Dementia	1.39 (1.11–1.74)	.004
Urolithiasis	1.44 (1.31–1.59)	<.001

*Adjusted for age, sex, UTI, BPH, indwelling urinary catheter, cerebrovascular disease, diabetes, dementia, and urolithiasis.

AHR = adjusted subdistribution hazard ratio, BPH = benign prostatic hyperplasia, CI = confidence interval, HR = subdistribution hazard ratio, OA = osteoarthritis, UTI = urinary tract infection.

of follow-up. In the outcome measurements, "any UTI" is the easiest outcome to be reached, followed by "≥1 hospitalization for UTI" and "≥3 hospitalizations." Therefore, the "end of follow-up" is shortest in "any UTI," followed by "≥1 hospitalization for UTI" and "≥3 hospitalizations." Because of the different length of follow-up, the percentage of mortality is lowest in the comparison for "any UTI," followed by "≥1 hospitalization for UTI" and "≥3 hospitalizations."

The present study's major strengths are its nationwide design, large sample size, and the clarification of an uncertain issue. The limitations are as follows. First, detailed information related to UTI, including activities of daily living (e.g., Barthel index) and the reason for the functional impairment, were not available in the NHIRD, which may confound the present results. However, we had matched age, sex, and adjusted the potential risk factors for UTI. The adjusted potential risk factors included common causes of functional impairment (i.e., cerebrovascular disease, diabetes, and dementia). Thus, we believe that the confounding effect is minimal. Second, although we found an association between OA and UTI, the causal relationship between OA and UTI could not be entirely clarified because there is a complex interaction among OA, UTI, and other comorbidities. Third, we did not have the data to analyze the proportion of OA responsible for patient's functional impairment. Fourth, the present result may not be generalized to other nations because of the differences in race, culture, and medical insurance. Further studies including more variables such as activities of daily living, the reason for the functional impairment, analysis of the proportion of OA responsible for functional impairment, and validation in other nations are warranted.

5. Conclusions

This nationwide population-based cohort study showed that OA was associated with UTI in older adults, especially in the age subgroup of ≥85 years old. Decreased physical activity in older patients with OA may be the major contributing factor. In addition to OA, other independent predictors for UTI were age 75 to 84 years, female sex, a history of UTI, BPH, an indwelling urinary catheter, cerebrovascular disease, dementia, and urolithiasis. We suggest appropriate management, including pain control, rehabilitation, surgery, and controlling other risk factors for UTI in older adults with OA to prevent subsequent UTI. Further studies, including recruiting data of daily activity and validation in other nations, are warranted.

Author contributions

W.-H.W., T.-H.T., Y.-W.C., and C.-C.H. (eighth author) designed and conceived this study. C.-H.H. and Y.-C.C. performed the statistical analysis C.-C.H. (fourth author), and H.-J.L., and J.-J.W. provided professional suggestions. All authors read, wrote, and approved the final manuscript.

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