

# Occupational risk factors associated with lower urinary tract symptoms among female workers: a systematic review

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## ABSTRACT

A systematic review was performed aiming to identify the various occupational risk factors of lower urinary tract symptoms (LUTS) among female workers. A systematic, comprehensive literature search of PubMed, Embase and Cochrane Library databases was conducted to identify studies published until 24 November 2021, evaluating the possible occupational risk factors of LUTS among female workers. Two reviewers assessed all articles retrieved through a computerised search for eligibility using predetermined criteria. Data on the first author, publication year, country, study design, participants, identified occupational risk factors, outcome variables and main results were extracted from the selected articles. The Newcastle–Ottawa Quality Assessment Scale guidelines were adopted to estimate the quality scores. Overall, our search yielded a total of 16 articles suitable for review. The occupational risk factors identified in the studies were strenuous physical demand and activity, prolonged sitting, occupational stress, shift work, limited use of the toilet at work and other occupational environments (eg, an unclean and uncomfortable workplace, dangerous job and probability of accidents, feeling pressed for time and awkward position for long periods). The findings of this review may raise awareness regarding the risk of LUTS among female workers with these factors. From an occupational health perspective, the implementation of tailored prevention strategies based on these occupational factors may prevent female workers from developing LUTS.

## PROSPERO registration number

CRD42022316728.

## INTRODUCTION

Lower urinary tract symptoms (LUTS) are frequent in women of all ages, especially those aged between 40 and 60 years. According to population-based studies, such as the Brazilian LUTS Epidemiology Research and the EPIC Study, LUTS affect 82% of Brazilian women<sup>1</sup> and 59.2% of women from five different countries, including Canada, Germany, Italy, Sweden and the UK.<sup>2</sup>

LUTS are a set of clinical symptoms involving the presence of annoying urological symptoms. LUTS include overactive bladder (OAB), urinary incontinence (UI), urine leakage, slow urine flow, intermittent urination, urinary hesitancy, urinary retention, terminal dribble, feelings of incomplete bladder emptying, post-urinary dribble and other suggestive urological syndromes.<sup>3</sup> These symptoms can seriously affect the patients' daily activities and health-related quality of life and place significant

## WHAT IS ALREADY KNOWN ON THIS TOPIC

- ⇒ Lower urinary tract symptoms (LUTS) are frequent in women of all ages, especially those aged between 40 and 60 years.
- ⇒ Considering that approximately 46% of women are employed worldwide and 39% of the total labour force are women, as well as the high prevalence rate of LUTS, improvement of knowledge related to the modifiable factors specific to female workers is necessary for designing effective medical and preventive interventions targeting the susceptible population before the symptoms develop and worsen.

## WHAT THIS STUDY ADDS

- ⇒ Overall, our search yielded a total of 16 articles suitable for review. The occupational risk factors identified in the studies were strenuous physical demand and activity, prolonged sitting, occupational stress, shift work, limited use of the toilet at work and other occupational environments.

## HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

- ⇒ The findings of this review may raise awareness regarding the risk of LUTS among female workers with these factors. From an occupational health perspective, the implementation of tailored prevention strategies based on these occupational factors may prevent female workers from developing LUTS.

economic burdens on the individuals, healthcare systems and society.<sup>4,5</sup> Existing evidence suggests that female workers with LUTS have significantly greater impairment in work productivity due to frequent toilet visits and deprived concentration.<sup>6</sup>

Although the pathogenesis of LUTS is poorly understood, several risk factors have been reported, including advanced age, higher parity, obesity, vaginal delivery, menopause, gynaecological surgery, constipation, chronic diseases, marital status, smoking, alcohol consumption and physical exertion.<sup>1,7–10</sup> In this context, some groups of workers with a high prevalence of LUTS have been identified.<sup>11</sup>

Considering that approximately 46% of women are employed worldwide and 39% of the total labour force are women,<sup>12</sup> as well as the high



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prevalence rate of LUTS, more information related to the modifiable factors specific to female workers is necessary to understand the possible influence of occupational factors and the workplace environment on LUTS and to design effective medical and preventive interventions targeting the susceptible population before the symptoms develop and worsen. Therefore, a systematic review was performed aiming to identify the various occupational risk factors of LUTS among female workers.

## METHODS

This review was performed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Statement criteria, and the protocol was registered prospectively in the PROSPERO (International Prospective Register of Systematic Reviews: registration no. CRD42022316728).

### Search strategy

A systematic, comprehensive literature search of PubMed, Embase and Cochrane Library databases was conducted to identify studies published until 24 November 2021, evaluating the possible occupational risk factors of LUTS among female workers. The search terms used to identify potentially relevant papers were women, working\*, occupational groups\*, employment\*, workplace\*, female\*, women\*, risk factors\*, occupational diseases\*, lower urinary tract symptoms\*, urinary incontinence\*, urinary bladder, overactive\* and pelvic floor disorders\* only in English. The terms were combined with the Boolean operator 'AND'. Detailed descriptions of the search strategies are provided in online supplemental file 1. After selection of articles suitable for review, additional articles were manually searched for further recent reports and directly from the reference lists of the identified studies.

### Study selection

The titles and abstracts of all articles retrieved through a computerised search were independently screened by two reviewers (HY and JYK). When the titles and abstracts provided insufficient information, a reprint of the full text was sought. Two reviewers (HY and JYK) assessed the full-text publications for eligibility using predetermined criteria. During the study selection process, disagreements between the two reviewers were discussed to reach a consensus; if necessary, a third-party reviewer (M-YK) was consulted.

Articles suitable for review were selected according to the selection criteria. All types of human peer-reviewed research publications (ie, descriptive epidemiological-occupational surveys, cross-sectional, cohort, case-control studies and case series) published in Korean or English and those reporting the possible occupational risk factors of LUTS among female workers in different, real and occupational exposure scenarios were considered. We defined the occupational risk factors in table 1. UI, urgency, frequency, nocturia, slow or intermittent stream, straining, hesitation and feelings of incomplete emptying, based on self-report or on their responses to a validated pelvic floor symptom outcome measure (ie, validated questionnaire and pad test), were all included. During screening, studies which did not meet inclusion criteria, those without statistical results or those that do not fit with the review topic were excluded.

### Data extraction and quality estimate

Data on the first author, publication year, country, study design, participants, identified occupational risk factors, outcome variables and main results were extracted. Two reviewers (HY and

JYK) independently assessed the quality of the included papers. A consensus was reached after discussions about the two reviewers' disagreements. A third-party reviewer (M-YK) was contacted, if required. The Newcastle-Ottawa Quality Assessment Scale guidelines adapted for cross-sectional studies were used to estimate the quality scores.<sup>13</sup> A higher score indicated better quality, with a maximum score of 10 points. Studies that scored a total of 9 or 10 points were considered to have a very low risk of bias; studies with 4 points or less were considered to have a high risk of bias. A low-quality score did not rule out any studies.

## RESULTS

### Study selection

Our preliminary research resulted in 276, 1620 and 17 records identified from the PubMed, Embase and Cochrane Library databases, respectively, with a total of 1913 articles. Meanwhile, 204 duplicates were removed, and 4 additional records were identified through a manual search. After title and abstract screening and report retrieval, 71 articles were selected for full-text review.

Among these, 55 articles were excluded as they did not meet the inclusion criteria due to the following reasons: the target population was not a female worker (9 records), the occupational risk factors were not presented (8 records), the statistical test results were not provided (4 records), the studies were grey literature or review articles (24 records) and the topic discussed in the studies was inconsistent with the subject of this review (10 records). Overall, our search yielded a total of 16 articles suitable for review. The review process is illustrated in figure 1.

### Study characteristics

The characteristics and findings of the possible occupational risk factors for LUTS among female workers in the selected studies are presented in table 1. The included studies were all written in English and published between 1999 and 2022. Among the included studies, four were conducted in the USA,<sup>14-17</sup> four in China,<sup>7 8 18 19</sup> one in Taipei,<sup>9</sup> one in India,<sup>20</sup> one in Portugal,<sup>10</sup> one in Korea,<sup>21</sup> one in Turkey,<sup>22</sup> one in Chile,<sup>23</sup> one in Brazil<sup>24</sup> and one in Iran.<sup>25</sup> All studies had a cross-sectional design. The quality of the included studies assessed using the Newcastle-Ottawa Quality Assessment Scale is presented in online supplemental file 2.

Thirteen of the 16 studies only included female participants with or without LUTS, while three studies included mixed-sex participants.<sup>8 18 25</sup> The occupations of the participants were as follows: air force active-duty women,<sup>14</sup> elementary school-teachers,<sup>9</sup> healthcare workers including nurses,<sup>7 16 18 19 22 24 25</sup> secretaries<sup>22</sup> and the general working population.<sup>7 8 10 15 17 20 21 23</sup> The most frequently studied occupation was healthcare workers. The outcome variables investigated were LUTS,<sup>7 9 17 20 22 25</sup> UI<sup>10 14 23</sup> and OAB.<sup>8 16 18 19</sup> The occupational risk factors identified in the studies were physical demand and activity, prolonged sitting,<sup>20</sup> occupational stress,<sup>9 18 19</sup> shift work,<sup>25</sup> limited use of the toilet at work<sup>9 17 22 24</sup> and other occupational environments.

### Physical demand and activity at the workplace

Results of research on physical demands and activity in the workplace varied. Salgado-Maldonado and Ramírez-Santana investigated the factors associated with UI in Chilean women.<sup>23</sup> The prevalence of UI was 45.01%, and it was associated with hard work (adjusted OR (AOR)=2.29, 95% CI=1.45 to 3.62), defined as 'work that requires several hours of standing, moving heavy objects (greater than 20 kg), going up and down the stairs, or spending more than 8 hours performing job-related tasks

**Table 1** Characteristics of included studies

First author	Year	Country	Study design	Participants	Occupational risk factors	Outcome variables	Main results
Fischer <sup>14</sup>	1999	USA	Cross-sectional	246 Air Force active-duty women on flying status	<ol style="list-style-type: none"> <li>Crew position: pilot, navigator, flight surgeon, weapon system operator/electronic warfare officer, load master</li> <li>Type of aircraft: high gravity, low gravity, not flying</li> <li>Total flying hours and average flying hours per month</li> </ol>	UI	<ol style="list-style-type: none"> <li>Crew position                             <ul style="list-style-type: none"> <li>Navigator: AOR=2.42, 95% CI=1.12 to 5.21</li> <li>Weapon system operator/electronic warfare officer: AOR=5.13, 95% CI=1.56 to 16.84</li> </ul> </li> <li>Type of aircraft: not significantly associated</li> <li>Total flying hours and average flying hours per month: not significantly associated</li> </ol>
Zhang <sup>7</sup>	2005	China	Cross-sectional	6066 women aged 20 years and older in Fuzhou (labour worker 18.7%)	Labour worker	LUTS (BFLUTS)	<ol style="list-style-type: none"> <li>Labour worker (compared with the unemployed)                             <ul style="list-style-type: none"> <li>LUTS: AOR=0.66, 95% CI=0.55 to 0.80</li> <li>Storage symptoms: AOR=0.61, 95% CI=0.50 to 0.74</li> <li>Voiding symptom: AOR=0.94, 95% CI=0.72 to 1.23</li> </ul> </li> <li>Urinary incontinence                             <ul style="list-style-type: none"> <li>Lower job control: AOR=2.20, 95% CI=1.37 to 3.52</li> <li>Urgency/Frequent straining to lift heavy objects at work: AOR=8.96, 95% CI=2.51 to 32.03</li> </ul> </li> </ol>
Liao <sup>9</sup>	2008	Taipei	Cross-sectional	445 female elementary schoolteachers	<ol style="list-style-type: none"> <li>Environmental factors                             <ul style="list-style-type: none"> <li>Adequacy of bathroom breaks</li> <li>Adequacy of toilet facility</li> <li>Availability of relief persons</li> </ul> </li> <li>Job conditions                             <ul style="list-style-type: none"> <li>Amount (length of time) of standing</li> <li>Frequency of straining to lift</li> <li>Job control</li> </ul> </li> </ol>	LUTS	<ol style="list-style-type: none"> <li>Urinary incontinence                             <ul style="list-style-type: none"> <li>Lower job control: AOR=2.20, 95% CI=1.37 to 3.52</li> <li>Urgency/Frequent straining to lift heavy objects at work: AOR=8.96, 95% CI=2.51 to 32.03</li> </ul> </li> </ol>
Avasarala <sup>20</sup>	2008	India	Cross-sectional	75 housewives, 75 working women and 180 adolescent girls	Prolonged sitting Type of toilets	LUTS	Prolonged sitting and bad toilet were contributing to LUTS among working women ( $\chi^2=6.99$ , $p<0.01$ )
Wang <sup>8</sup>	2011	China	Cross-sectional	14 844 men and women aged >18 years	Manual worker	OAB (OABSS)	Manual worker Women: AOR=1.714, 95% CI=1.593 to 1.843
Zhang <sup>19</sup>	2013	China	Cross-sectional	1070 registered female nurses with one or more years of nursing experience	Occupational stress Role overload Role insufficiency Role ambiguity Role boundary Responsibility Physical environment Psychological strain Vocational strain Interpersonal strain Physical strain Coping resources Recreation Self-care Social support Rational/cognitive coping	OAB	<ol style="list-style-type: none"> <li>Most of the subscales of occupational stress and psychological strain showed higher results for nurses with OAB than for those OAB-free</li> <li>Physical environment and interpersonal strain were positively associated with urgency, while rational/cognitive coping was negatively associated</li> <li>Role insufficiency, role ambiguity, psychological strain and level of recreation were somewhat associated with OAB risk</li> <li>Role ambiguity and physical environment were shown to have positive effects on frequency, as well recreation and rational/cognitive coping, which warrants careful interpretation</li> </ol>
Amaral <sup>10</sup>	2015	Portugal	Cross-sectional	505 women with UI who attended the urology and gynaecology services of four hospitals in central Portugal (47.3% employment)	<ol style="list-style-type: none"> <li>Employment status</li> <li>Sitting hours per day</li> <li>Frequently carrying more than 3 kg in weight</li> </ol>	UI	<ol style="list-style-type: none"> <li>Employed women (compared with unemployed/retired)                             <ul style="list-style-type: none"> <li>Stress UI: AOR=0.68, 95% CI=0.45 to 1.04</li> <li>Urgence UI: AOR=1.67, 95% CI=1.16 to 2.41</li> <li>Mixed UI: AOR=1.52, 95% CI=1.03 to 2.26</li> </ul> </li> <li>Hours seated/day longer than 2 hours (compared with less than 2 hours)                             <ul style="list-style-type: none"> <li>Stress UI: AOR=1.34, 95% CI=0.86 to 2.09</li> <li>Urgence UI: AOR=0.64, 95% CI=0.43 to 0.94</li> <li>Mixed UI: AOR=0.57, 95% CI=0.38 to 0.86</li> </ul> </li> <li>Frequently carry &gt;3 kg in weight                             <ul style="list-style-type: none"> <li>Stress UI: AOR=0.76, 95% CI=0.39 to 1.49</li> <li>Urgence UI: AOR=0.60, 95% CI=0.35 to 1.02</li> <li>Mixed UI: AOR=0.47, 95% CI=0.27 to 0.80</li> </ul> </li> </ol>

continued

Table 1 continued

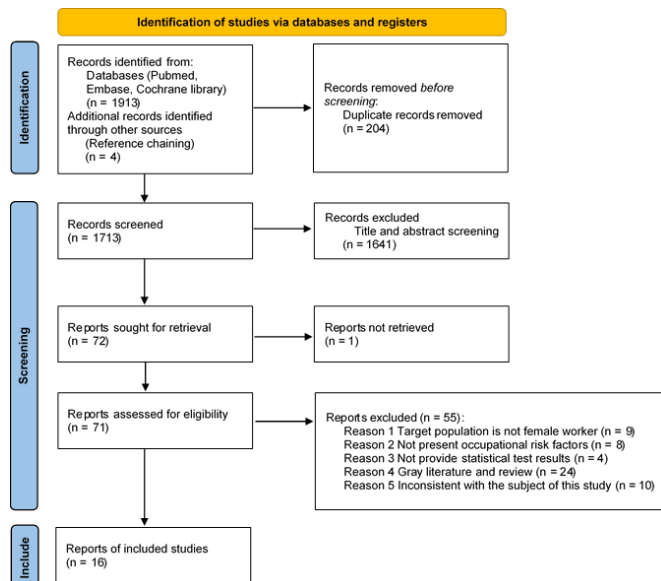
First author	Year	Country	Study design	Participants	Occupational risk factors	Outcome variables	Main results
Kaya <sup>22</sup>	2016	Turkey	Cross-sectional	281 women ▲ 218 (77.5%) nurses and 63 (22.5%) secretaries	Being too busy to drink fluid at work Reduced fluid consumption at work Drinking no fluid until being thirsty at work Delaying urinating at work Adequacy of toilet facility Availability of another person when one is at toilet Heavy lifting at work	LUTS	1. There were no significant differences in the prevalence of any type of LUTS between nurse and secretary groups 2. In the following situations, participants had experienced at least one more type of LUTS than the others – Too busy to drink (p=0.011) – Did not drink fluids until feeling thirsty (p=0.001) – Did not have adequate toilet facilities (p=0.015) – Delayed urinating (p=0.001) – Did not have anyone to do their work when they were at the toilet (p=0.023) – Lifting heavy loads at work (p=0.003)
Kim <sup>21</sup>	2017	Korea	Cross-sectional	2985 working women and 2943 unemployed women (using data from the fourth Korea National Health and Nutrition Examination Survey)	1. Occupational status – Job classification – Employment status – Work type – Working hours – Work schedule pattern 2. Occupational environment – Unclean and uncomfortable workplace – Dangerous job and probability of accidents – Feeling pressed for time – Awkward position for long periods – Carrying heavy weights	UI	1. Compared with unemployed women – Paid workers: AOR=1.81, 95% CI=1.20 to 2.73 – Self-employed workers: AOR=1.46, 95% CI=1.05 to 2.03 – Working in services/sales: AOR=1.62, 95% CI=1.21 to 2.19 – Daytime work schedule: AOR=2.14, 95% CI=1.18 to 3.87 – Evening work schedule: AOR=1.35, 95% CI=1.05 to 1.74 2. UI was significantly associated with various occupational environments: an unclean and uncomfortable workplace, dangerous job and probability of accidents, feeling pressed for time, awkward position for long periods and carrying heavy weights
Palmer <sup>16</sup>	2018	USA	Cross-sectional	182 employed women who were working at a large academic medical centre	Among toileting behaviours (TB-WEB) ▲ Delay emptying my bladder when I am busy ▲ Wait too long (strong need to urinate or actual leakage) when I have to empty my bladder at work	UI (ICIQ-SF) OAB (ICIQ-OAB)	Wait too long (strong need to urinate or actual leakage) when I have to empty my bladder at work UI=1.57 to 39.24
Reynolds <sup>17</sup>	2019	USA	Cross-sectional	3062 full-time working women	Limit use of the bathroom at work	LUTS (ICIQ-FLUTS)	Limit restroom use at work ▲ Urgency: AOR=1.39, 95% CI=1.04 to 1.86 ▲ Stress incontinence: AOR=1.33, 95% CI=1.01 to 1.76 ▲ UI/monthly: AOR=1.52, 95% CI=1.18 to 1.94
Xu <sup>18</sup>	2019	China	Cross-sectional	400 operating room nurses in five hospitals ▲ Women (84%)	1. Nurse job stress scale – Occupational stressor: heavy workloads, low salary, lack of an opportunity for promotion, fear of making a mistake in treating a patient, low social status, lack of an opportunity to continue education, frequent night shifts, not enough staff to adequately cover the unit, too many non-nursing tasks required, not enough time to provide emotional support to a patient 2. Work role – Scrub nurse or other	OAB (OABSS)	▲ Occupational stress: AOR=1.026, p<0.001 ▲ Scrub nurse: AOR=4.636, p<0.001

continued

**Table 1** continued

First author	Year	Country	Study design	Participants	Occupational risk factors	Outcome variables	Main results
Salgado-Maldonado <sup>23</sup>	2020	Chile	Cross-sectional	371 female patients aged 30 years and older	<ul style="list-style-type: none"> <li>Hard work</li> <li>Defined as 'work that requires many hours of standing, moving heavy objects (greater than 20 kg), going up and down stairs, or more than 8 hours of work daily'</li> </ul>	UI	Hard work: AOR=2.29, 95% CI=1.45 to 3.62
Nerbass <sup>24</sup>	2021	Brazil	Cross-sectional	133 female workers employed in five nephrology centres (66 nurses and 67 controls)	<ul style="list-style-type: none"> <li>The nursing staff</li> <li>Performed their activities in dialysis rooms</li> <li>Toilets and water supplies were available outside of the dialysis rooms</li> <li>Due to infection control regulations, water bottles are not permitted in the nurse workstations</li> </ul>	Urinary tract symptoms and infection episodes	<ul style="list-style-type: none"> <li>Nurse group showed higher prevalence of</li> <li>Burning sensation: 50% vs 27%, p&lt;0.001</li> <li>Urinary urgency: 42% vs 21%, p&lt;0.001</li> <li>Infection: 42% vs 25%, p=0.04</li> </ul>
Kim <sup>15</sup>	2022	USA	Cross-sectional	30 213 women aged 20 years and older (using data from the National Health and Nutrition Examination Survey)	Physical activity levels at work	UI	<ul style="list-style-type: none"> <li>Moderate intensity work</li> <li>Stress UI: AOR=0.84, 95% CI=0.70 to 0.99</li> <li>Urge UI: AOR=0.84, 95% CI=0.70 to 0.99</li> <li>Mixed UI: AOR=0.66, 95% CI=0.45 to 0.97</li> <li>Vigorous-intensity work</li> <li>Stress UI: AOR=0.98, 95% CI=0.76 to 1.26</li> <li>Urge UI: AOR=1.00, 95% CI=0.74 to 1.34</li> <li>Mixed UI: AOR=1.18, 95% CI=0.76 to 1.82</li> </ul>
Alamdari <sup>25</sup>	2022	Iran	Cross-sectional	228 nurses <ul style="list-style-type: none"> <li>148 female (64.9%)</li> <li>80 male (35.1%)</li> </ul>	Shift work	LUTS	A significant relationship was observed between LUTS and shift work in female staff (p=0.037)

AOR, adjusted OR; BFLUTS, Bristol Female Lower Urinary Tract Symptoms Questionnaire; FLUTS, female LUTS; ICIQ-SF, International Consultation on Incontinence Questionnaire-Short Form; LUTS, lower urinary tract symptoms; OAB, overactive bladder; OABSS, Overactive Bladder Symptom Score; TB-WEB, Toileting Behaviors-WEB Scale; UI, urinary incontinence.



**Figure 1** Preferred Reporting Items for Systematic Reviews and Meta-Analyses Statement flow diagram of study selection process.

daily'. Another study was conducted using a population-based cross-sectional field survey in China.<sup>8</sup> A total of 14 844 individuals (7614 men and 7230 women) with complete data were analysed. Results showed that manual work was one of the potential risk factors for OAB in women compared with mental work (AOR=1.714, 95% CI=1.593 to 1.843). Liao *et al* also reported that lifting heavy objects at work was associated with urgency (AOR=8.96, 95% CI=2.51 to 32.03) among female elementary schoolteachers in Taipei.<sup>9</sup>

On the contrary, Zhang *et al* evaluated the risk factors of LUTS among 6066 women in China and reported that compared with the unemployed, labour workers have a decreased risk of LUTS (AOR=0.66, 95% CI=0.55 to 0.80) and storage symptoms (AOR=0.61, 95% CI=0.50 to 0.74).<sup>7</sup> Likewise, an analysis of 30 213 women in the 2008–2018 National Health and Nutrition Examination Survey showed that women who engaged in moderate activity work were less likely to report stress, urge and mixed incontinence (AOR=0.84, 95% CI=0.70 to 0.99; AOR=0.84, 95% CI=0.70 to 0.99; and AOR=0.66, 95% CI=0.45 to 0.97, respectively), although vigorous-intensity work did not show significant results.<sup>15</sup> Another study conducted in 505 women with UI who attended the urology and gynaecology services of four hospitals in central Portugal indicated that the likelihood of urge UI was reduced among women who spent more than 2 hours seated per day (AOR=0.64, 95% CI=0.43 to 0.94).<sup>10</sup> Additionally, the likelihood of mixed UI was reduced among women who spent more than 2 hours a day seated (AOR=0.57, 95% CI=0.38 to 0.86) and who frequently carried more than 3 kg (AOR=0.47, 95% CI=0.27 to 0.80). In a similar context to physical inactivity in the workplace, prolonged sitting posture was examined. In a study conducted in India, a house-to-house survey was performed in two villages and an urban ward. Analysis of 75 working women revealed that prolonged sitting contributed to the occurrence of LUTS ( $X^2=6.99$ ,  $p<0.01$ ).<sup>20</sup>

### Occupational stress

The relationship with occupational stress is consistent across studies. Xu *et al* investigated the associations among occupational stress, toileting behaviours and OAB among 400 eligible

operating room nurses in five hospitals in China.<sup>18</sup> The different survey questionnaires used in the study included the Nurse Work Stress Scale, the Toileting Practices Scale and the OAB Symptom Score Questionnaire. Results revealed that OAB was highly prevalent among male and female nurses working in operating rooms, especially among scrub nurses (AOR=4.636,  $p<0.001$ ). With high levels of occupational stress, nurses adopt unhealthy toileting behaviours to empty their bladders, which mediate the relationship between occupational stress and OAB. The more nurses engaged in unhealthy toileting practices such as delaying urination and straining to urinate, the higher their probability to develop OAB. Another study of female nurses in China evaluated the prevalence of OAB and other LUTS, and their association with occupational stress.<sup>19</sup> After analysing the responses to 1070 valid questionnaires, nurses with OAB had higher scores on most subscales of occupational stress and psychological strain than those without OAB. After adjusting for age, body mass index, and history of childbearing and pelvic surgery, each subscale of occupational stress was associated with at least one type of LUTS. Specifically, physical environment and interpersonal strain were positively associated with urgency, whereas rational/cognitive coping was negatively associated with urgency. Additionally, role insufficiency, role ambiguity and psychological strain were related to OAB risk to some extent.

### Restriction on restroom at work

Restrictions on restroom use at work were as well consistently reported to be associated with the risk of LUTS across studies. Female employees of a large academic medical centre in the USA were surveyed to examine their bladder health and toileting behaviours.<sup>16</sup> Among the 182 women who participated in the survey, those who waited too long to urinate at work reported increased odds of urinary urgency (AOR=7.85, 95% CI=1.57 to 39.24). Reynolds *et al* investigated the risk factors for UI among women working full-time in the USA.<sup>17</sup> Approximately 11% of the 3062 women in the final analytical sample responded that they used the toilet only sometimes or never at work, and it was associated with urgency (AOR=1.39, 95% CI=1.04 to 1.86), stress incontinence (AOR=1.33, 95% CI=1.01 to 1.76) and UI (AOR=1.52, 95% CI=1.18 to 1.94). In an online survey conducted at five nephrology centres in Brazil, 66 nurses and 67 controls were compared.<sup>24</sup> The nurses were assigned in the dialysis rooms, and the toilets and water supplies were available outside of the dialysis rooms. Owing to the infection control regulations, water bottles are not permitted in nurses' workstations. As a result, the nurse group showed a higher prevalence of burning sensation (50% vs 27%,  $p<0.001$ ), urinary urgency (42% vs 21%,  $p<0.001$ ) and infection (42% vs 25%,  $p=0.04$ ). Liao *et al* also reported that restrictions regarding using the toilet freely at work was associated with UI (AOR=2.20, 95% CI=1.37 to 3.52) among female elementary schoolteachers in Taipei.<sup>9</sup>

### Shift work

Alamdari *et al* investigated the prevalence of LUTS and the impact of shift work on symptoms among the staff of public hospitals in Iran.<sup>25</sup> A total of 222 female and male workers were surveyed (64.9% and 35.1%, respectively). The prevalence of LUTS among women was higher than men (61.1% vs 44.2%,  $p=0.016$ ). In this study, shift work was defined as a work that occurs on a schedule outside the normal 09:00–17:00 pattern. Results showed a significant relationship between LUTS and shift work in female staff ( $p=0.037$ ), but not in male staff ( $p=0.368$ ).

### Other occupational environments

Kaya *et al* examined the relationship between work-related factors and LUTS among 218 nurses and 63 secretaries in Turkey.<sup>22</sup> No significant differences were observed in the prevalence of any type of LUTS between the nurse and secretary groups. In the following situations, however, participants had experienced at least one type of LUTS than the others: too busy to drink ( $p=0.011$ ), did not drink fluids until feeling thirsty ( $p=0.001$ ), did not have adequate toilet facilities ( $p=0.015$ ), delayed urination ( $p=0.001$ ), did not have anyone to perform their work when they were at the toilet ( $p=0.023$ ) and lifting heavy loads at work ( $p=0.003$ ). Analysis of the data from the fourth Korea National Health and Nutrition Examination Survey (2008–2009) further revealed significant associations between UI and many working situations: an unclean and uncomfortable workplace, dangerous job and probability of accidents, feeling pressed for time, awkward position for long periods and carrying heavy weights.<sup>21</sup> The risk factor for UI in the US Air Force female aircrew included crew position (navigator: AOR=2.42, 95% CI=1.12 to 5.21; weapon system operator/electronic warfare officer: AOR=5.13, 95% CI=1.56 to 16.84), but the type of aircraft, total flying hours and average flying hours per month were not significantly associated.<sup>14</sup>

### DISCUSSION

To the best of our knowledge, this review was the first to comprehensively identify the possible occupational risk factors for LUTS among female workers. Although definite conclusions were not established due to the limited number of available studies, some inconsistent results and several ambiguous findings with too wide CIs, which could compromise the interpretation of results in the primary studies, some critical aspects that require further investigation could be pointed out. Our review found that LUTS were associated with strenuous physical demands, shift work, prolonged sitting, occupational stress, limited use of the restroom at work and other occupational environments (eg, an unclean and uncomfortable workplace, dangerous job and probability of accidents, feeling pressed for time and awkward position for long periods).

The results of studies on physical demands and activity in the workplace varied. The following factors may explain these inconsistent findings. An increase in intra-abdominal pressure that occurs during physical activity tends to induce stress UI. By contrast, exercise may result in increased muscle mass and strength. Considering the fact that weakness and atrophy of the pelvic floor play an important role in the pathophysiology of stress UI, certain types of physical activity may facilitate the unintended contraction of the pelvic floor and thus strengthen the pelvic floor muscles.<sup>26</sup> The finding that participation in frequent intense training sports can increase the cross-sectional area of the levator ani, a major muscle group for supporting the pelvic organs and maintaining continence, supports this hypothesis.<sup>27</sup> However, some women with manual jobs may have more physical demands at work (eg, heavy lifting or strenuous activity) than those who engaged in moderate level of physical activity at work, which may lead to stress UI. This disparity may reflect the population examined in each study, suggesting that the intense and high-impact physical demand observed in manual hard workers promotes stress UI, while the more moderate but sustained physical activity observed in the general working population may prevent the occurrence of incontinence, especially in the long run. Previous researches have reported that high-impact (landing) sport sustained for prolonged periods may

lead to the development of stress UI in women, suggesting that repeated hard physical activity at work may lead to alterations in pelvic floor muscle function.<sup>28</sup> It has been suggested that repetitive high-impact exercise may overload pelvic floor muscles, which may result in stress injuries to muscle and related structures including fascia or ligaments.<sup>29</sup> The degree of influence on pelvic floor muscle strengthening might also vary depending on the type of moderate activity, but it would have been difficult to confirm all of them because the detailed information on these factors was not included in the studies.

In addition to strengthening the pelvic floor, a modest degree of physical activity may have additional favourable benefits for bladder control in patients with OAB.<sup>15</sup> Physical activity can lower cognitive stress, which is also associated with OAB symptoms<sup>30</sup> and pain condition in the lower urinary tract, such as interstitial bladder inflammation/painful bladder syndrome.<sup>31</sup> Therefore, another possible mechanism for the relationship between moderate levels of physical activity and the decreased risk of LUTS is that physical activity reduces stress and improves urine storage symptoms as a secondary effect.

Significant evidence suggests that occupational stress and its corresponding physiological and psychological responses can have many adverse health effects.<sup>32</sup> Stress can adversely affect the lower urinary tract. Klausner and Steers suggested that the expression of corticotropin-releasing factors in certain areas of the central nervous system in response to stress can cause pain and dysfunction of the pelvic organ as well as anxiety and depression.<sup>33</sup> Corticotropin-releasing factors play a role in mediating the emotional impact on bladder function, thus linking anxiety or emotional stress with the development of urinary disorders. Xu *et al* suggested the mediating role of toileting behaviours in the relationship between occupational stress and OAB among operating room nurses.<sup>18</sup> With high levels of occupational stress, nurses adopt unhealthy toileting behaviours to empty their bladders, which mediates the relationship between occupational stress and OAB. The most common behaviour was delayed urination. This phenomenon is referred to as 'infrequent voiding syndrome' or 'nurses' bladder'.<sup>34</sup> Consequently, poor toileting practices may contribute to the onset or progression of OAB.

A probable but understudied risk factor of OAB is chronic infrequent urination at work. This may be the result of maladaptive behaviour learnt over time due to environmental influences and social norms. In fact, infrequent urination at work can occur due to limitations in toilet access and availability, lack of autonomy to use the toilet when needed and unavoidable choices that can reduce urine production (eg, fluid restriction).<sup>11</sup> This behaviour can also be attributed to the professional activities of working women. For example, working in hot/cold conditions, stressful job demands and wearing certain clothes can limit the ability to go to the bathroom when needed. Many women in certain occupations take adaptive actions to manage their urination needs, such as reducing fluid and caffeine intake, and wearing absorbent products to prevent accidents. However, most studies on this topic have not directly evaluated the rate of toilet access but have only examined the prevalence of LUTS in a single type of occupation type that hypothesised potentially limited toilet access and low urination frequency.<sup>21</sup>

Shift work has been found to cause not only sleep disorders but also gastrointestinal diseases, coronary artery disease, metabolic syndrome, and breast and prostate cancer.<sup>35</sup> Considering the inter-relationship between sleep disorders and LUTS, the effects of shift work on various urological complications can also be inferred. A previous study suggested that impaired sleep quality is associated with more significant LUTS in male shift workers through

the mechanism by which impaired sleep from shift work leads to increased psychological stress that exacerbates urinary symptoms.<sup>36</sup> However, only a few studies examined the relationship between shift work and LUTS, and even the studies conducted so far were results from the male population. Alamdari *et al* showed a significant relationship between LUTS and shift work among female staff in public hospitals in Iran. Considering these results, the high prevalence of LUTS among nurses reported in other studies may be attributed to shift work.

The most commonly studied groups are healthcare workers, especially nurses, although knowledge of nursing workforce regarding LUTS is still limited. Overall, the prevalence of LUTS was much higher among nurses, reaching 89.6%.<sup>37</sup> The factors associated with occupational roles were job stress, shift work schedules, lifting heavy weights and poor bladder habits. However, studies on other occupations are still limited. This may characterise a possible bias in the interpretation of the obtained results due to specific conditions that healthcare workers may experience compared with those with other jobs. These may include that they have a relatively large amount of medical knowledge and good access to medical services; hence, they can be easily diagnosed and treated. Therefore, future studies across broad occupational types may shed light on the associations between occupational factors and LUTS.

In this systematic review, studies were fully searched to explore the possible occupational risk factors for LUTS. However, some limitations of the currently available studies should be addressed in future studies. First, there is a high level of heterogeneity among studies which deal with various occupational risk factors, and insufficient number of articles qualified for each risk factor to perform quantitative analysis (online supplemental file 3). Previous studies may have suffered from an underestimation of the problem as LUTS may be considered as 'part of life' or 'part of ageing' and even talking about it often is still considered shame or a taboo. Moreover, since only studies published in English and peer-reviewed journals were considered, a total of 64 papers are excluded, respectively, in PubMed (n=20) and Embase (n=44). For these reasons, the risk of language and publication bias seems likely to be substantially high. Although it was not assessed through funnel plot or Egger's test because while there are various types of risk factors, the number of studies for each of them was not large, caution should be taken when interpreting the results of this review. Second, all available studies were performed in a cross-sectional manner; even though quality scores for studies were evaluated as satisfactory, good or very good (online supplemental file 2), no causal relationships could be drawn between the occupational risk factors and LUTS due to the shortcoming of the research design. Third, there are concerns regarding the measurement of the main occupational exposures. Since majority of the included studies used non-validated measurement tool (online supplemental file 3), their methodological quality was considered low to moderate. Moreover, different measures of LUTS were used across studies: self-report or validated pelvic floor symptom outcome measurement (eg, validated questionnaires and pad tests). In this sense, future studies should use standardised objective measures to better understand the causality of the association between LUTS and various occupational risk factors. This may help clarify the different impacts of various occupational factors on the prevalence of LUTS and determine the complex interplay between different occupational risk factors.

## CONCLUSION

LUTS were associated with strenuous physical demand, shift work, prolonged sitting, occupational stress, limited use of the

restroom at work and other occupational environments. The findings of this review may raise awareness regarding the risk of LUTS among female workers with these factors. From an occupational health perspective, the implementation of tailored prevention strategies based on these occupational factors may prevent female workers from developing LUTS.

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