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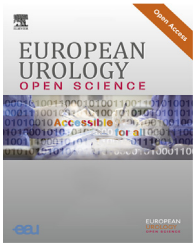

European Association of Urology

Female Urology - Incontinence

Prevalence and Spatial Distribution Characteristics of Female Stress Urinary Incontinence in Mainland China

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Abstract

Background and objective: Stress urinary incontinence (SUI) in women is a common condition that affects middle-aged and elderly women. Currently, there are still many limitations in the epidemiological research on SUI. This study aims to address the gap in the prevalence of female SUI in mainland China and provide theoretical support for the prevention and treatment of SUI.

Methods: A comprehensive literature search was conducted on the prevalence of female SUI in mainland China, systematically searching Chinese and English databases including PubMed, Web of Science, Embase, Cochrane Library, China National Knowledge Infrastructure (CNKI), Wanfang Database, and Weipu Database as of April 1, 2024. Detailed criteria for screening and exclusion were established. The prevalence of SUI in the selected studies was synthesized using Stata MP (version 15) software, and a multisubgroup analysis, a sensitivity analysis, and publication bias detection of the prevalence of SUI were also performed using the software. Additionally, ArcGIS software (version 10.8) and Geoda software (version 1.2) were utilized to explore the geographical distribution characteristics of the prevalence of female SUI in mainland China.

Key findings and limitations: A total of 688 articles were screened, and finally 85 articles were included. The overall rate of female SUI in mainland China was 24.5% (95% confidence interval: 22.5–26.5%). The heterogeneity of the study is statistically significant (I^2 = 99.0%, $p < 0.001$). Based on significant heterogeneity, a multisubgroup analysis was conducted. The results showed that the prevalence of SUI varies among different publication years, literature quality scores, investigators, study settings, sampling methods, provinces, regions, coastal or inland areas, and rural or urban areas. A spatial econometric analysis indicated that the incidence of SUI in the east-west distribution showed a downward trend, while in the north-south distribution, the incidence rate of SUI showed a trend of first

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increasing and then decreasing. Additionally, a spatial metrology analysis showed similar trends in the distribution of SUI incidence.

Conclusions and clinical implications: The high incidence rate of female SUI in mainland China and the regional differences observed indicate the need for further rigorous epidemiological investigation in the future.

Patient summary: Stress urinary incontinence (SUI) is common among middle-aged and elderly women. The high prevalence of SUI in mainland China and the differences across regions emphasize the need for conducting more robust epidemiological studies in the future.

1. Introduction

According to the International Continence Society, urinary incontinence (UI) is defined as "the complaint of any involuntary loss of urine" and is divided into three categories: stress urinary incontinence (SUI), urgent urinary incontinence (UUI), and mixed urinary incontinence (MUI) [1,2]. SUI is the most common UI, characterized by involuntary urine leakage due to increased intra-abdominal pressure during activities such as coughing, sneezing, and laughing [3]. SUI can significantly impact a woman's quality of life, leading to decreased work productivity, social isolation, mental disorders, and increased mortality, posing a burden on the health care system [4]. The etiology of SUI is complex and diverse, often caused by pelvic floor injury resulting from childbirth, surgical treatment, or tumor radiotherapy, with risk factors including obesity, smoking, pregnancy, multiple vaginal deliveries, menopause, multiple medications, and lung diseases leading to chronic cough [5,6]. It is widely recognized that conducting epidemiological research on SUI is crucial for early identification and intervention of risk factors, management of high-risk populations, and prevention and treatment of SUI.

Epidemiological research on SUI faces several challenges. First, discrepancies in the definition and measurement methods of UI can lead to inconsistencies in research results. Most survey studies rely on patient self-reporting as the main source of information, with objective tests such as pressure tests, pad tests, voiding diaries, and urodynamic examinations rarely used to confirm the condition. Additionally, the lack of a standardized and effective questionnaire in survey studies results in inconsistent conclusions in epidemiological research [7,8]. However, overall, in questionnaire surveys, the majority of adult women report occasional leakage during physical activity, while half of young women who have not given birth report occasional leakage with coughing, sneezing, or exercise [9]. Although few young women report daily leakage, about 10% of middle-aged women report daily or severe UI, and one-third report leakage at least weekly [10]. Second, the prevalence of SUI varies among different age groups, regions, and ethnic groups, adding complexity to the research. The prevalence of SUI also differs among various ethnic and racial groups [11,12]. For example, in a large population-based study of middle-aged women, non-Hispanic Black and Hispanic women were found to have a 60% lower likelihood of severe SUI than non-Hispanic White women after adjusting for various comorbidities [13]. Third, as UI is a private and sensitive health issue, some patients may be unwilling to openly discuss or report their symptoms, potentially leading to biased research results. Studies have shown that only about one-fourth of women with UI consult health care professionals for this condition [14,15]. Lastly, the etiology of UI is complex and diverse, involving physiological, anatomical, psychological, and social factors, further increasing the difficulty of epidemiological research [6,16]. Therefore, the integration and comprehensive analysis of epidemiological research on SUI are particularly important and urgent to address these challenges and improve our understanding of this condition.

China has conducted significant research in the epidemiology of UI [17–20]. A population survey based on 18 992 samples found that the prevalence of SUI in China is 18.9%, and it increases with age, peaking at 50–60 yr of age [21]. However, due to factors such as survey methods, survey areas, and age ranges, Chinese epidemiological studies on UI show significant heterogeneity. Studies report that the prevalence of SUI in adult Chinese women fluctuates between 9.1% and 40.1%, and the identified risk factors also vary [22,23]. These differences limit the use of epidemiological data by health authorities in formulating prevention and control policies. A meta-analysis is a systematic review method used to statistically integrate and analyze the results of multiple independent studies [24]. In the field of epidemiology, a meta-analysis is typically used to integrate and synthesize the results of multiple studies on a specific disease, risk factor, or treatment method in order to obtain more comprehensive and reliable conclusions [25]. In addition, a spatial distribution analysis in epidemiology is an important method used to study the geographical distribution patterns and characteristics of diseases [26]. Through this analysis, information such as disease incidence rates in different geographical areas, epidemic transmission pathways, and hotspots of epidemic outbreaks can be discovered, providing a scientific basis for disease control and prevention [27]. In the current study, a meta-analysis and a spatial distribution analysis are employed to integrate comprehensively the prevalence data of female SUI in mainland China through epidemiological research. Additionally, these methods are used to forecast the trend of incidence

rates using spatial metrology, aiming to offer theoretical support for the subsequent prevention and treatment of SUI.

2. Methods

This meta-analysis complied with the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) and was pre-registered on the International Prospective Register of Systematic Reviews (PROSPERO) with registration number CRD42023459422.

2.1. Literature search strategy

The English and Chinese literature databases, including Web of Science, PubMed, Embase, Cochrane Library, China National Knowledge Infrastructure (CNKI) Database, Wanfang Database, and Weipu Database, were systematically searched up to April 1, 2024. The important search strategies are as follows: Web of Science: (TS = stress urinary incontinence OR TS = SUI) AND ([TS = prevalence] OR TS = epidemi*) AND ([(TS = Chinese) OR TS = China] OR TS = mainland); PubMed: ([stress urinary incontinence(Title/Abstract)] OR SUI(Title/Abstract)] AND [(prevalence(Title/Abstract)] OR epidemi*[Title/Abstract]) AND ([(Chinese [Title/Abstract]) OR China[Title/Abstract]) OR mainland [Title/Abstract]; CNKI: AB = stress urinary incontinence AND (AB = prevalence OR AB = epidemiology); Wanfang Database: Abstract: (stress urinary incontinence) (prevalence + epidemiology); Chongqing VIP: R = stress urinary incontinence(R = prevalence + R = epidemiology). Furthermore, the reference lists of the retrieved articles were reviewed to identify additional eligible studies. Unpublished studies were not included. The search was limited to English and Chinese languages.

2.2. Inclusion and exclusion criteria

The inclusion criteria were as follows: (1) epidemiological studies on the prevalence and incidence of primary SUI in women, (2) studies conducted in mainland China, (2) cross-sectional studies, (3) studies with sample size and prevalence rate reported in the literature, and (4) studies published in English or Chinese. Conversely, studies were excluded if these met any of the following seven exclusion criteria: (1) review, comments, case reports, meeting reports, letters to editors, etc.; (2) literature that did not mention geographical location or related data; (3) repetitive literature was included with the most complete data or the latest publication age, while others were excluded; (4) literature not published in English or Chinese; (5) low-quality literature, unclear diagnostic criteria, or unrelated studies; (6) research targeting specific populations including those with recurrent SUI and those who have undergone various treatments for SUI; and (7) studies of Taiwan, China Province, Hong Kong, and Macao Special Administrative Regions of China.

2.3. Quality evaluation

The STROBE declaration literature quality evaluation standards with 12 items are used to evaluate the quality of each literature. For each item, 1 point is awarded for meeting the standard requirements, while 0 points are awarded for not mentioning or not conforming to the standard. Two researchers will individually assess each item, and in case of any disagreement, a consensus will be reached after consulting with a third researcher from the experimental group. Each item meeting the criteria will be awarded 1 point, while those not meeting the criteria will receive 0 points. The literature quality is categorized based on the scores: low (0–3 points), medium (4–7 points), and high (8–12 points). Only high-quality literature that falls into the high category is ultimately included. Each article can score between 0 and 12 points, with literature scoring $\leq$8 points was considered to be of low quality and therefore excluded.

2.4. Statistical analyses

Stata MP (version 15; Stata Corp., College Station, TX, USA) was used to conduct the meta-analysis. Significant heterogeneity between studies, indicated by a confidence interval (CI) of >95% and $p < 0.05$, led to the use of an effect model to estimate the combined prevalence rate [28]. The I^2 statistics and Q tests were employed to assess the heterogeneity among included studies, with a threshold p value of 0.05 considered statistically significant [29]. I^2 values of 25%, 50%, and 75% were interpreted as mild, moderate, and highly heterogeneous, respectively, while values <50% were considered acceptable. Subgroup analyses were performed by publication year, sampling, study setting, investigator, province, geographical area, inland/coastal, rural/urban, and literature quality to explore possible sources of heterogeneity. Funnel plots, Begg's test, and Egger's test were utilized to check for a potential publication bias, with $p \leq 0.05$ considered statistically significant.

ArcGIS software (version 10.8; Esri, Redlands, CA, USA) was used to create a statistical map of the pooled prevalence rate in each province and to conduct a trend analysis chart to evaluate spatial changes in diseases [30]. The X, Y, and Z axes of the chart represent longitude, latitude, and prevalence, respectively. Geoda software (version 1.2; Geoda, Tel Aviv, Israel) was employed for a spatial autocorrelation analysis of SUI. The Global Moran's I index was used to evaluate global spatial autocorrelation, while the Lisa cluster map and Lisa significance map were used to describe local spatial autocorrelation [31,32].

3. Results

3.1. Literature search

The process of literature search, screening, exclusion, and inclusion in this study is depicted in Figure 1. We systematically searched the Web of Science, PubMed, Embase, Cochrane Library, CNKI, Wanfang Data, and Weipu Database up to April 1, 2024, and identified a total of 668 articles, of which 142 were duplicates. After screening the abstracts and titles of these publications, we retained 526 articles.

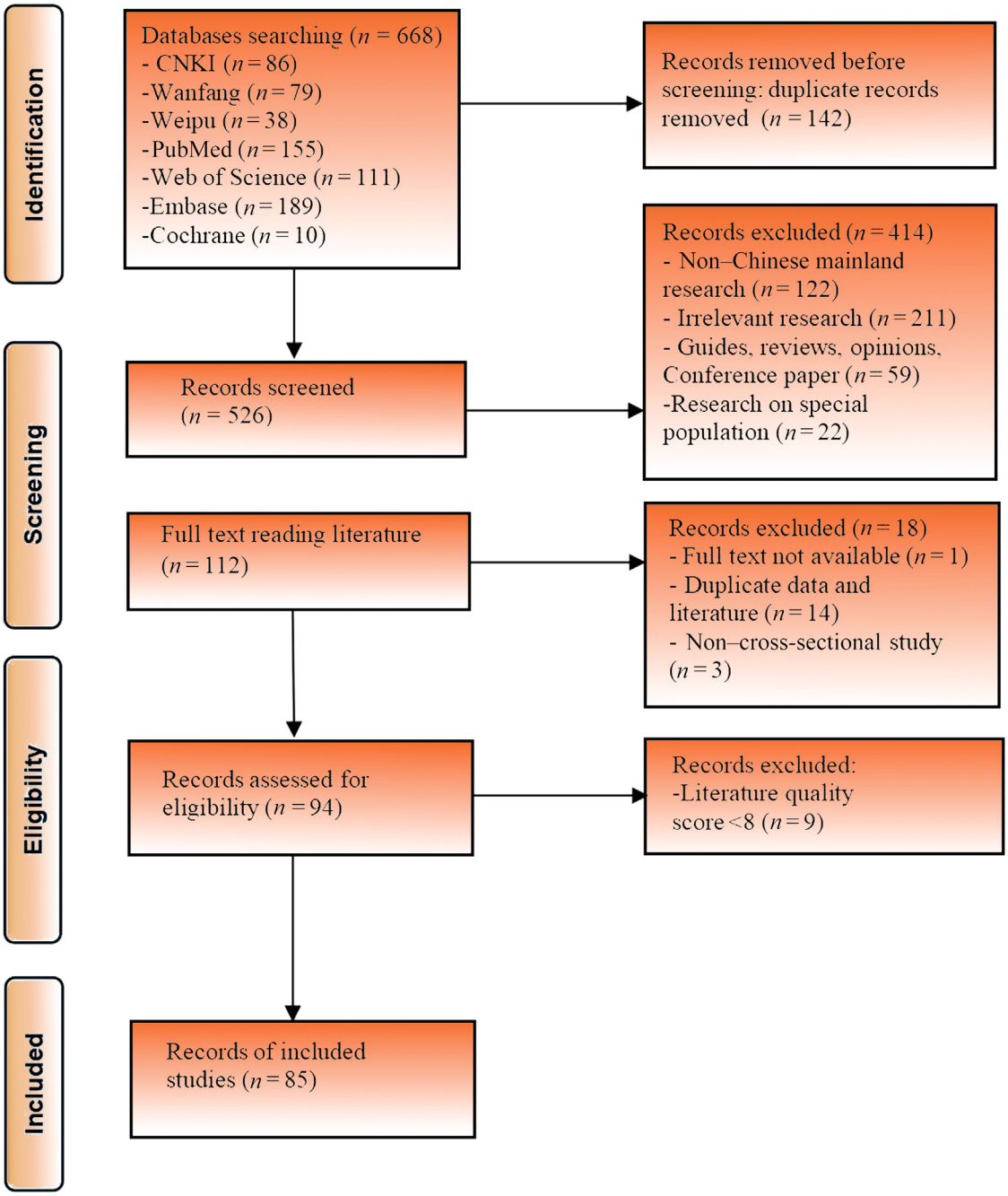

Fig. 1 – Flow chart illustrating the identification of included studies. CNKI = China National Knowledge Infrastructure.

Of these articles, 414 were excluded: 112 for non–mainland China research; 211 for irrelevant research; 59 for being guides, reviews, opinions, and conference papers; and 22 for research on special populations. Therefore, 112 articles entered the full-text literature reading section. Of these articles, another 18 were eliminated: one for full text not available, 14 for duplicate data and literature, and three for being non–cross-sectional studies. After reading the full text, 94 articles were eligible. The articles with low scores (literature quality <8) were excluded, and finally, 85 articles were included.

3.2. *Characteristics of studies*

The characteristics of the included studies are presented in Supplementary Table 1. All the articles are cross-sectional studies. Among the 85 articles, 15 were published in English, while 70 were published in Chinese. By year and geographic location, the 85 studies were conducted between 2004 from 2023 across 23 of mainland China's 34 provinces, municipalities, and autonomous regions: 23 in East China, 21 in North China, 14 in South China, six in Southwest China, eight in Central China, two in Northeast China, ten

in Northwest China, and one in mainland China. There were 64 articles on the population sampling method of regional cluster sampling, 17 articles on the population sampling method of regional stratified sampling, three articles on the population sampling method of convenience sampling, and one article on the population sampling method of 1% population composition ratio. Sixty-two studies were set in community; the remaining 23 studies were set in hospitals. Of these studies, 19 were conducted in coastal areas, while 65 were conducted in inland areas; one study was conducted simultaneously in coastal and inland areas. Fifty-nine studies were implemented in urban areas, six were implemented in rural areas, ten were implemented both in urban and rural areas, and nine did not mention whether these were implemented in rural or urban areas. There were 64 studies conducted by medical staff and 21 studies conducted by a uniform trained investigator. The assessment methods varied across the 85 studies. Specifically, 55 studies used self-administered questionnaires, six studies used self-administered questionnaires in combination with gynecological examinations, and 14 studies utilized the International Consultation on Incontinence Questionnaire—Short Form (ICI-Q-SF). Additionally, one study employed the ICI-Q-SF questionnaire along with gynecological examinations, while another study used the Incontinence Quality of Life (I-QOL) questionnaire. Furthermore, one study combined the ICI-Q-SF and I-QOL questionnaires, and one study used the Bristol Female Lower Urinary Tract Symptoms (BFLUTS) questionnaire. Moreover, one study utilized both the BFLUTS and the ICI-Q-SF questionnaire, while another study employed opportunistic screening, and two studies used face-to-face interviews. Lastly, two studies utilized the BFLUTS questionnaire as their assessment method. The quality scores of the 85 articles ranged from 8 to 12 points, with 11, 16, 23, 23, and 12 articles rated as having 8, 9, 10, 11, and 12 points, respectively.

3.3. *Pooled prevalence of SUI in mainland China*

As indicated in Supplementary Table 1 (characteristics of included studies), the prevalence of female SUI in mainland China varied across the studies, ranging from 7.5% to 44.69%. As shown in Figure 2, the pooled prevalence of female SUI across all 85 studies was calculated to be 24.5% (95% CI: 22.5–26.5%). It is important to note that there was statistically significant heterogeneity among the studies (I^2 = 99.0%, p < 0.001).

3.4. *Subgroup analyses*

3.4.1. *Publication year*

As shown in Table 1, the pooled prevalence of SUI from articles published in 2014 or later was found to be 0.246 (95% CI: 0.213–0.280), while the pooled prevalence of SUI from articles published before 2014 was 0.244 (95% CI: 0.225–0.265).

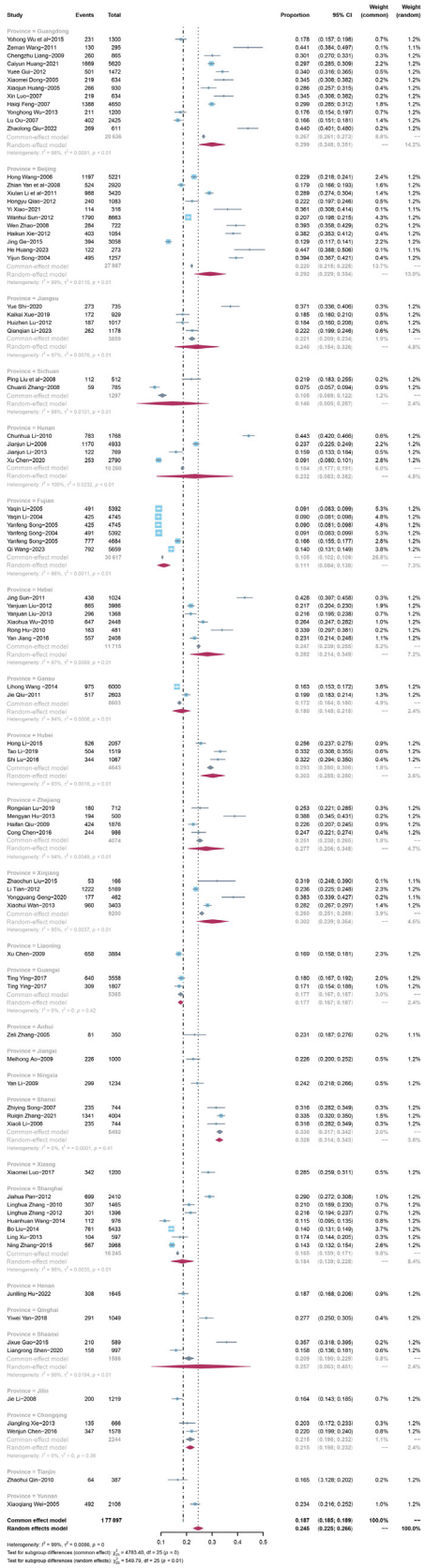

Fig. 2 – Forest plot for a subgroup analysis by provinces. CI = confidence interval.

Table 1 – Subgroup of pooled prevalence of female SUI in Chinese mainland

Subgroup	No. of studies	Prevalence (%)	95% CI		Heterogeneity		
			Lower	Upper	Q	*p* value	I^2 (%)
Publication year							
<2014	53	24.4	0.222	0.265	5585.40	<0.001	99.1
≥2014	32	24.5	0.213	0.280	2487.73	<0.001	98.8
Sampling							
Regional cluster sampling	64	24.2	0.223	0.262	6263.68	<0.001	99.0
Regional stratified sampling	17	26.6	0.223	0.309	1703.42	<0.001	99.1
1% population composition ratio	1	22.9	0.218	0.241	0	0	–
Convenience sampling	3	17.2	0.152	0.192	3.90	0.142	48.8
Study setting							
Community	62	23.3	0.214	0.252	6320.75	<0.001	99.0
Hospital	23	27.5	0.238	0.312	1389.95	<0.001	98.4
Investigator							
Medical staff	64	25.4	0.231	0.276	6991.14	<0.001	99.1
Uniform trained investigator	21	21.6	0.194	0.238	1076.48	<0.001	98.1
Geographical area							
South China	14	28.1	0.240	0.322	775.07	<0.001	98.3
North China	21	28.6	0.254	0.318	1275.21	<0.001	98.4
East China	23	19.3	0.169	0.217	1589.42	<0.001	98.6
Southwest China	6	20.6	0.141	0.270	235.04	<0.001	97.9
Central China	8	25.3	0.175	0.331	1096.37	<0.001	99.4
Northwest China	10	25.8	0.220	0.296	378.95	<0.001	97.6
Northeast China	2	16.8	0.158	0.178	0.19	0.661	0
Province							
Guangdong	12	29.9	0.255	0.343	555.27	<0.001	98.0
Beijing	11	29.0	0.245	0.336	801.62	<0.001	98.8
Jiangsu	4	24.0	0.168	0.311	88.50	<0.001	96.6
Sichuan	2	14.6	0.005	0.287	48.82	<0.001	98.0
Hunan	4	23.2	0.100	0.364	855.66	<0.001	99.6
Fujian	6	11.1	0.087	0.135	235.93	<0.001	97.9
Hebei	6	28.1	0.230	0.331	190.54	<0.001	97.4
Gansu	2	18.0	0.145	0.215	15.56	<0.001	93.6
Hubei	3	30.3	0.251	0.354	29.56	<0.001	93.2
Zhejiang	4	27.6	0.220	0.332	46.29	<0.001	93.5
Xinjiang	4	30.0	0.251	0.349	56.45	<0.001	94.7
Liaoning	1	16.9	0.158	0.181	0	–	–
Guangxi	2	17.7	0.167	0.187	0.66	0.418	0
Anhui	1	23.1	0.187	0.276	0	–	–
Jiangxi	1	22.6	0.200	0.252	0	–	–
Ningxia	1	24.2	0.218	0.266	0	–	–
Shanxi	3	33.0	0.317	0.342	1.81	0.405	0
Xizang	1	28.5	0.259	0.311	0	–	–
Shanghai	7	18.4	0.142	0.226	290.17	<0.001	97.9
Henan	1	18.7	0.168	0.206	0	–	–
Qinghai	1	27.7	0.250	0.305	0	–	–
Shannxi	2	25.7	0.063	0.451	74.97	<0.001	98.7
Jilin	1	16.4	0.143	0.185	0	–	–
Chongqing	2	21.5	0.198	0.232	0.84	0.359	0
Tianjin	1	16.5	0.128	0.202	0	–	–
Yunan	1	23.4	0.216	0.252	0	–	–
China	1	18.9	0.183	0.195	0	–	–
Inland/coastal							
Inland	65	26.0	0.242	0.279	4270.36	<0.001	98.5
Coastal	19	19.2	0.164	0.219	1459.43	<0.001	98.8
Rural/urban							
Rural	6	19.2	0.156	0.227	114.03	<0.001	95.6
Urban	58	25.0	0.228	0.273	6084.54	<0.001	99.0
Quality score							
8	11	28.6	0.219	0.353	1607.30	<0.001	99.4
9	16	22.1	0.172	0.270	1867.21	<0.001	99.2
10	23	24.6	0.215	0.276	1488.77	<0.001	98.5
11	23	22.3	0.189	0.256	1602.93	<0.001	98.6
12	12	28.0	0.217	0.343	1476.53	<0.001	99.3

CI = confidence interval; SUI = stress urinary incontinence.

3.4.2. *Sampling method*

As shown in Table 1, the pooled prevalence of SUI from studies utilizing regional cluster sampling was 0.242 (95% CI: 0.223–0.262). For studies employing regional stratified sampling, the pooled prevalence was 0.266 (95% CI: 0.223–0.309). Meanwhile, the pooled prevalence from studies using convenience sampling was 0.172 (95% CI: 0.152–0.192).

3.4.3. *Study setting*

As shown in Table 1, the pooled prevalence of SUI in community settings was 0.233 (95% CI: 0.214–0.252), while

the composite prevalence of SUI in hospital settings was 0.275 (95% CI: 0.238–0.312).

3.4.4. Investigator

As shown in Table 1, the combined prevalence of SUI in studies conducted by medical staff was 0.254 (95% CI: 0.231–0.312), whereas the pooled prevalence of SUI in studies conducted by researchers as uniform trained investigators was 0.216 (95% CI: 0.194–0.238).

3.4.5. Geographical area

As shown in Table 1, the prevalence of SUI varied significantly across seven geographical regions in China. The highest prevalence was observed in North China (0.286, 95% CI: 0.254–0.318), while the lowest was in Northeast China (0.168, 95% CI: 0.158–0.178). South China (0.281, 95% CI: 0.240–0.322) had a similar prevalence to North China, and Central China (0.253, 95% CI: 0.175–0.331) was similar to Northwest China (0.258, 95% CI: 0.220–0.296). The prevalence in East China was 0.193 (95% CI: 0.240–0.322), and in Southwest China, it was 0.206 (95% CI: 0.141–0.270).

3.4.6. Province

As shown in Figure 2 and Table 1, the prevalence of SUI varied significantly among the 27 provinces in China based on the data available. Shanxi had the highest prevalence of SUI (0.330, 95% CI: 0.317–0.342), while Fujian had the lowest prevalence (0.111, 95% CI: 0.087–0.135). The prevalence in Xinjiang (0.300, 95% CI: 0.251–0.349) and Hubei (0.303, 95% CI: 0.251–0.354) was similar. Similarly, Xizang (0.285, 95% CI: 0.259–0.311), Beijing (0.290, 95% CI: 0.245–0.336), and Guangdong (0.299, 95% CI: 0.255–0.343) had similar prevalence rates. Yunnan (0.234, 95% CI: 0.216–0.252), Anhui (0.231, 95% CI: 0.187–0.276), Jiangxi (0.226, 95% CI: 0.200–0.252), and Hunan (0.232, 95% CI: 0.100–0.364) had similar prevalence rates. The prevalence in Shanghai (0.184, 95% CI: 0.142–0.226) and Henan (0.187, 95% CI: 0.168–0.206) was also similar. Jilin (0.164, 95% CI: 0.143–0.185), Tianjin (0.165, 95% CI: 0.128–0.202), and Liaoning (0.169, 95% CI: 0.158–0.181) had similar prevalence rates. Zhejiang (0.276, 95% CI: 0.220–0.332) and Qinghai (0.277, 95% CI: 0.250–0.305) also had similar prevalence rates. Jiangsu (0.240, 95% CI: 0.168–0.311) and Ningxia (0.242, 95% CI: 0.218–0.266) had similar prevalence rates. The prevalence in Guangxi (0.177, 95% CI: 0.167–0.187) was similar to that in Gansu (0.180, 95% CI: 0.145–0.215). Sichuan had a prevalence of 0.146 (95% CI: 0.005–0.287), while Chongqing had a prevalence of 0.215 (95% CI: 0.198–0.232). The prevalence of SUI in Shaanxi was 0.257 (95% CI: 0.063–0.451), while in Hebei, it was 0.281 (95% CI: 0.230–0.331). Based on the existing data, the prevalence of SUI in mainland China was 0.245 (95% CI: 0.225–0.265), according to the analysis of a random-effect model.

3.4.7. Inland/coastal

As shown in Table 1, the prevalence of SUI in inland areas was 0.260 (95% CI: 0.242–0.279), while the prevalence of SUI in coastal areas was 0.192 (95% CI: 0.164–0.219).

3.4.8. Rural/urban

As shown in Table 1, the prevalence of SUI in rural areas was 0.192 (95% CI: 0.156–0.227), while the prevalence was 0.250 (95% CI: 0.228–0.273) in urban areas.

3.4.9. Quality score

As shown in Table 1, the pooled prevalence was 0.286 (95% CI: 0.219–0.353) for studies with a literature quality score of 8, 0.221 (95% CI: 0.172–0.270) for studies with a literature quality score of 9, 0.246 (95% CI: 0.215–0.276) for studies with a literature quality score of 10, 0.223 (95% CI: 0.189–0.256) for studies with a literature quality score of 11, and 0.280 (95% CI: 0.217–0.343) for studies with a literature quality score of 12.

3.5. Spatial metrology analysis

3.5.1. Spatial, temporal, and population distributions

Figure 3 illustrates the regional distribution of SUI prevalence. The map indicates varying prevalence rates across different provinces, with Shanxi recording the highest prevalence at 0.330 (95% CI: 0.317–0.342) and Fujian reporting the lowest prevalence at 0.111 (95% CI: 0.087–0.135). Overall, North China exhibited the highest prevalence of SUI at 0.286 (95% CI: 0.254–0.318), while Northeast China had the lowest prevalence at 0.168 (95% CI: 0.158–0.178).

3.5.2. Spatial trend distribution

In the east-west distribution (X axis), the prevalence of SUI exhibited a decreasing trend, as indicated by the fitted trend line (green curve). Conversely, in the north-south distribution (Y axis), the prevalence of SUI displayed an initial increase followed by a decrease. The fitted trend line (blue curve) mirrored this pattern, with a low prevalence at both ends and a higher prevalence in the middle, as depicted in Figure 4A. Additionally, in Figure 4B, the Moran's I value was –0.193, with a pseudo p value of 0.194, suggesting no global spatial autocorrelation. However, as demonstrated in Figures 4C and 4D, the prevalence in Henan exhibited a clustering pattern from low to high, with a significance level of $p = 0.05$.

4. Discussion

UI refers to the symptom of involuntary loss of urine [1,2]. This is a common and embarrassing problem, leading to increased individual morbidity, decreased quality of life, and increased socioeconomic costs. In addition to the loss of bladder control, the need to use incontinence pads often damages the individuality and self-confidence of young prepartum women [33–35]. The manifestations of UI include occasional leakage of urine when coughing or sneezing (SUI), or UI accompanied by urgency (UUI), or a combination of both (MUI) [36]. Among these, SUI is the most common type, posing significant health risks for women, and its pathogenesis is relatively clear, making it easily preventable through intervention in risk factors [37]. At present, there is extensive research on the prevalence and incidence of SUI. However, the reported prevalence and/or incidence figures vary significantly

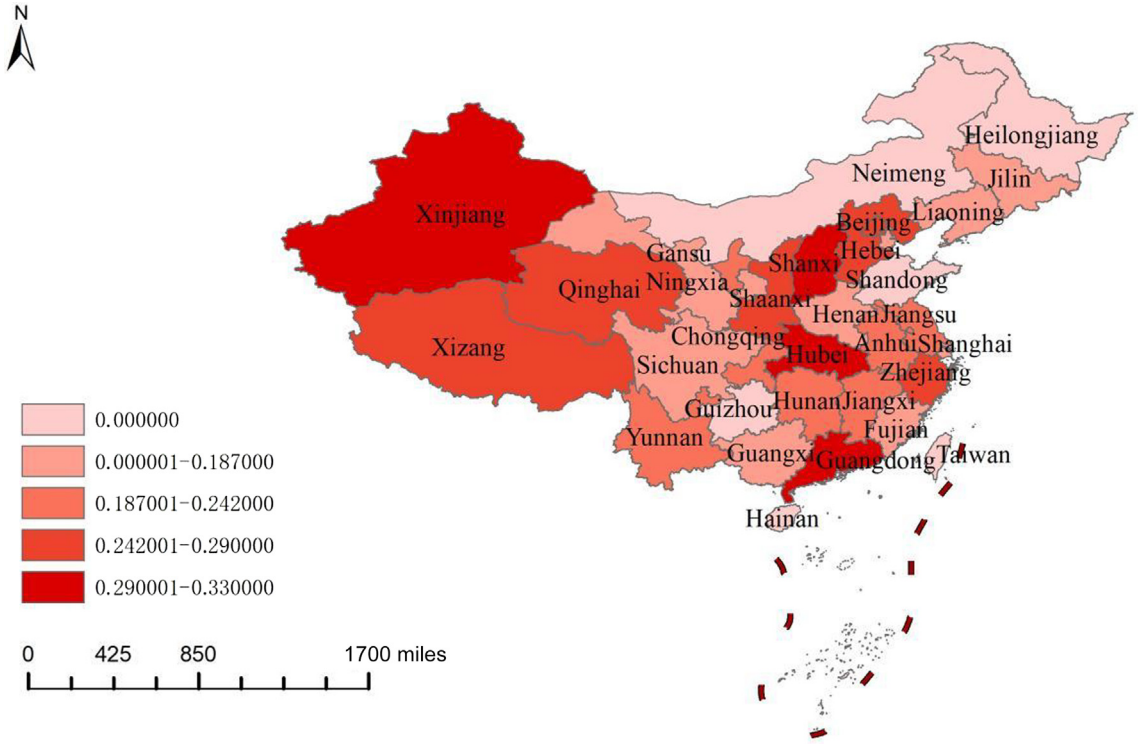

Fig. 3 – Prevalence of female SUI in different provinces of China. SUI = stress urinary incontinence.

depending on the local setting, case definitions, recruited population, and study methodology [38–41]. It is unfortunate that these epidemiological studies still lack consistent conclusions and quantitative analysis findings. Particularly in China, as a country with diverse ethnicities, rich cultural backgrounds, complex geographical environments, and extensive territories, the significant data heterogeneity in existing SUI epidemiological studies weakens their reference value for the prevention and management of SUI [17–20]. Therefore, this study is the first to quantitatively synthesize and trend analyze the epidemiology of SUI in mainland China, aiming to establish a theoretical basis for implementing regional and personalized prevention and treatment strategies for SUI.

This study synthesized the prevalence data of SUI from 85 studies and found that the overall incidence rate of SUI among women in Chinese mainland was 24%. The incidence rate of SUI in Chinese mainland is lower than that of some developed countries. For example, the 2015–2018 National Population-Based Survey data in the USA showed that 37.5% of people had SUI [42]. An epidemiological survey was conducted in 29 500 community-dwelling women aged 18 yr and above in four European countries, with Spain having the lowest prevalence of SUI (23%), while France, Germany, and the UK had prevalence rates of 44%, 41%, and 42%, respectively, with SUI being the most common type [43]. The study also investigated the prevalence and impact of SUI among 500 women in Jordan, where 200 (40%) women reported SUI [44]. In Egypt, a total of 3600 adult men and women participated in the survey, with UI reported by 21% and SUI by only 4% [45]. Meanwhile, the prevalence of SUI was found to be 3.3% among Saudi women in a descriptive cross-sectional study conducted in the Kingdom of Saudi Arabia [46]. In Japan, a randomly sampled cross-sectional Internet survey among 3030 women aged 20–64 yr showed an overall incidence rate of SUI of around 18% [47]. The differences in analysis results may have several reasons, including population composition, survey methods, regional differences, and cultural factors. First, community management in China is not standardized enough, and the mechanism of family doctors is not as sound as in developed countries. Second, domestic epidemiological surveys use international survey questionnaires that have not been validated sufficiently and understood domestically. Third, people from Eastern culture may have a stronger sense of shame toward SUI than those from other regions, and women are often unwilling to report UI. Last, there is significant heterogeneity in the prevalence of SUI among different regions in Chinese mainland, which requires further in-depth exploration of the incidence situation.

Owing to significant heterogeneity in this study, in order to further explore the source of heterogeneity, we conducted subgroup analyses on publication year, sampling method, study setting, investigators, and study quality. The results show that the overall prevalence of SUI in the past decade is relatively stable compared with the previous decade, suggesting a stable state in mainland China. The prevalence investigated using regional cluster sampling and regional stratified sampling methods is higher than that from convenience sampling, indicating the importance of research methods in the epidemiological study of UI [48]. The prevalence investigated in hospitals is higher than that

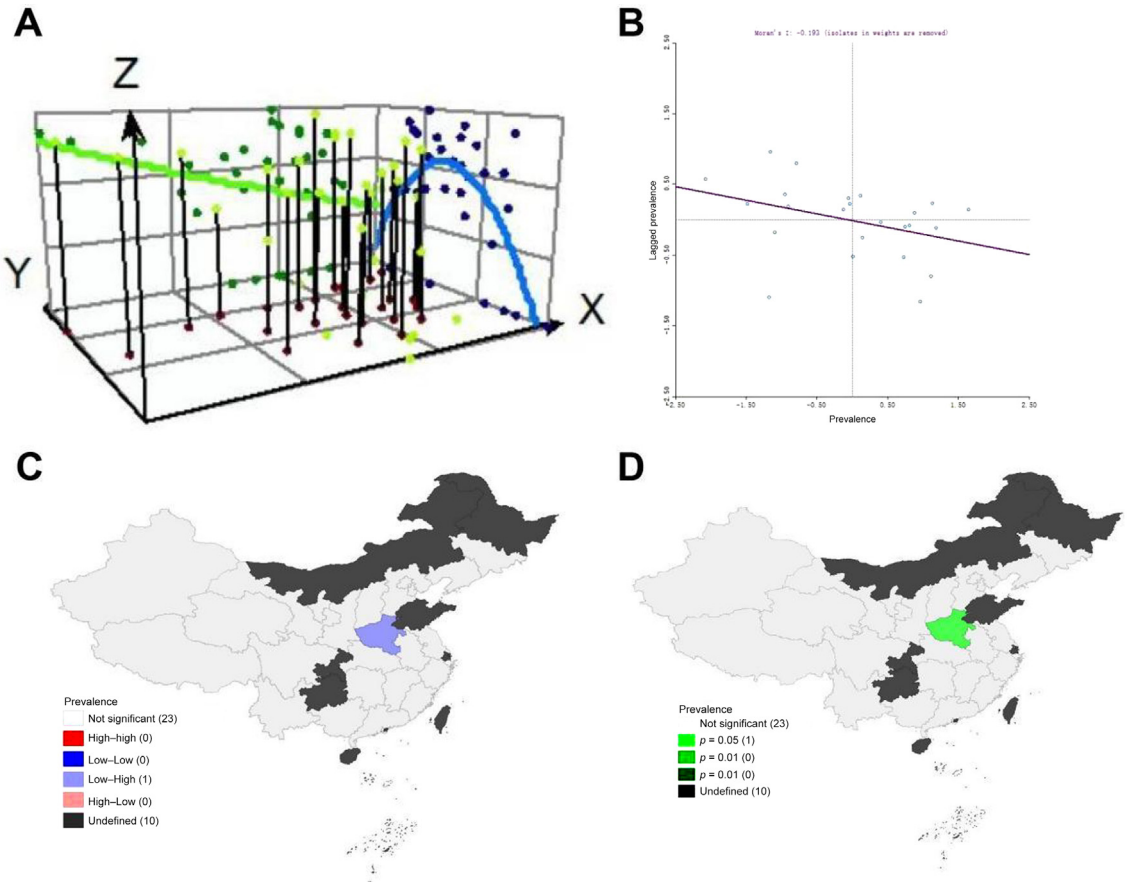

Fig. 4 – Spatial trend distribution of female SUI: (A) trend analysis, (B) Moran's scatterplot, (C) Lisa concentration map, and (D) Lisa significance map. SUI = stress urinary incontinence.

in community surveys, and the prevalence investigated by medical staff is higher than that by uniform trained investigators, suggesting the importance of professional examinations in the epidemiological investigation of SUI [49,50]. Additionally, the quality of literature also affects the reported results, with different quality literature reporting different prevalence of SUI [51]. These research conclusions are generally consistent with the regularities observed in other epidemiological studies; therefore, it is necessary to study carefully the biases that the study itself may have on the results of epidemiological research [18,23,52].

The study also performed subgroup analyses based on geographical area, province, inland/coastal location, and rural/urban classification. The findings revealed a higher prevalence of SUI among urban female residents than among their rural counterparts, indicating that lower urinary tract symptoms, including SUI, are more prevalent in urban women in China [53]. This trend may be linked to the higher obesity rate resulting from the dietary habits of urban women, with obesity being a well-known risk factor for SUI [16,54,55]. In mainland China's urban and rural systems, urban areas generally have more developed economies than rural areas [56]. The elevated prevalence of SUI in urban areas, as indicated by the research results, could also be associated with greater awareness and collaboration among women in more developed regions in terms of SUI prevention and treatment [57]. Additionally, rural women's limited self-awareness of SUI, compounded by factors, such as older age, lower education level, and lower income, exacerbates the issue [58–60]. Furthermore, our research findings demonstrate a lower incidence of SUI in coastal women than in those in inland regions. Among the existing research in coastal areas, the prevalence of SUI among women in Fujian Province was the lowest, possibly due to Fujian Province being the first in mainland China to investigate the epidemiology of female SUI [60]. Coastal areas were pioneers in conducting epidemiological research on SUI, which may have been influenced by less advanced technical methods at the time, resulting in a lower incidence rate. Additionally, the developed economy in coastal areas, compared with inland regions, may contribute to higher health awareness and more advanced concepts for preventing and treating SUI among women, leading to a lower prevalence of SUI than among inland women. This could be attributed to the heightened professionalism of medical staff in diagnosing and identifying diseases, resulting in a higher incidence of SUI in hospitals and through surveys conducted by medical staff [61]. Additionally, we conducted an assessment of the temporal and spatial distribution of female SUI in mainland China. Our findings indicate that SUI does not exhibit global spatial autocorrelation in mainland China. Henan is identified as an area with a varying prevalence of SUI, ranging from low to high clustering. This inconsistent outcome may be

attributed to the presence of numerous missing values. Notably, data are unavailable for four provinces. Further research may be necessary to investigate the spatial autocorrelation of SUI.

This study has several significant advantages compared with previous research. First, it is the first systematic review and meta-analysis of the epidemiology of SUI in mainland China. The study has a broad scope, including 85 studies with a total of 196 921 participants, spanning a 20-yr period. Second, the study conducted comprehensive subgroup analyses, covering nine aspects such as publication year, sampling method, study setting, investigator, geographical area, province, inland/coastal, rural/urban, and quality score, making it the most comprehensive data summary to date. Third, the study utilized a spatial metrology analysis for the first time to explore the distribution characteristics of SUI in mainland China. Several limitations should be acknowledged in this study. First, only studies in English or Chinese were included in this meta-analysis, which might cause a publication bias. Second, heterogeneity is evident in this study, and although a subgroup analysis was conducted, heterogeneity still needs to be taken seriously. Third, the spatial trend analysis of this study is a rough and simple analysis, and a higher-level disease prediction model has not yet been constructed, laying the foundation for effective disease prevention and control.

5. Conclusions

In conclusion, the present meta-analysis suggests that female SUI has a high incidence rate in China. The prevalence differs by sampling methods, region, population, and study quality. More rigorous large-scale epidemiological studies are needed to determine the incidence probability and trend of SUI [62–132].

***Author contributions*:** Quan Zhou had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: L. Li, Zhou.
Acquisition of data: L. Li, Zhou.
Analysis and interpretation of data: Dai, Lu.
Drafting of the manuscript: L. Li, Zhou.
Critical revision of the manuscript for important intellectual content: Peng.
Statistical analysis: L. Li, G. Li.
Obtaining funding: L. Li, Zhou.
Administrative, technical, or material support: Zhou.
Supervision: Zhou.
Other: Zhou.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.euros.2024.08.007.

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