Int Urogynecol J (2012) 23:563–572
DOI 10.1007/s00192-011-1640-8

ORIGINAL ARTICLE

Prevalence and risk factors for peri- and postpartum urinary incontinence in primiparous women in China: a prospective longitudinal study

Lan Zhu · L. Li · Jing-he Lang · T. Xu

Received: 23 May 2011 / Accepted: 24 December 2011 / Published online: 26 January 2012

Abstract
Introduction and hypothesis We sought to characterize risk factors of urinary incontinence (UI) during pregnancy and the postpartum period in primiparous women in China.
Methods We enrolled 10,098 women from the seven regions of China ≥28 weeks' gestation from September 2007 to May 2009 and administered the Bristol Female Lower Urinary Tract Symptoms questionnaire to estimate the presence of different types of UI during late pregnancy (37 to 42 weeks' gestation) and at 6 weeks and 6 months postpartum. We also collected details of pregnancy and childbirth and demographic data. McNemar's test, multinomial logistic regression models, and binary logistic regression models were used.
Results Multivariable analysis revealed six independent risk factors for SUI: age, more frequent exercise, alcohol consumption, higher body mass index, larger waist circumference, and history of constipation. For those with no UI in late pregnancy, 3.7% and 3.0% developed new cases at 6 weeks and 6 months postpartum, respectively. Risk factors for UI at 6 months were frequent exercise, rural residence, perineal laceration, and lateral episiotomy. Prevalence of all UI was 26.7% in late pregnancy, 9.5% at 6 weeks postpartum, and 6.8% at 6 months postpartum. Most cases were stress urinary incontinence (18.6%, 6.9%, and 5.0%, at the respectively times).
Conclusions Rates of UI in primiparous women in China are consistent with those reported elsewhere. Rural location, frequent exercise, and birth-related injuries are risk factors for UI at 6 months postpartum.

Keywords Urinary incontinence · Risk factors · Primiparous women · National cohort

Introduction

Urinary incontinence (UI) in women is a recognized problem worldwide, with different etiologies for older and postpartum women [1–5]. Pregnancy is known to raise the incidence of all types of UI, and first pregnancy in particular is associated with a high rate of new-onset UI [4–10]. Both the processes of pregnancy and delivery are associated with higher risk of developing UI [6, 11]. Rates have been established in developed countries (around 30% in postpartum women), but less is known for developing countries [9]. Since UI may persist for years and rates increase with age, understanding the factors associated with its development will help clinicians identify those at greatest risk for targeted intervention [1, 6–9, 12].

Different types of UI may be associated with different risk factors such as age, menopause, obesity, and medical conditions such as diabetes mellitus, but few studies have attempted to characterize them. A multinational survey of 7,879 primiparous women found stress urinary incontinence (SUI) began more frequently during pregnancy and urge urinary incontinence (UUI) more frequently after delivery, while mixed urinary incontinence (MUI) began at either time [7]. Another study found an association of greater

L Zhu and L Li contributed equally to this work.

L. Zhu (✉) · L. Li · J.-h. Lang (✉)
Department of Obstetrics and Gynecology,
Peking Union Medical College,
Beijing 100730, China
e-mail: zhu_julie@sina.com
e-mail: langjh@hotmail.com

L. Li
e-mail: lilin_0909@163.com

T. Xu
Department of Epidemiology and Statistics,
Chinese Academy of Medical Science & School of Basic Medicine, Peking Union Medical College,
Beijing 100730, People's Republic of China

maternal age with SUI and having SUI during pregnancy; UUI was associated with lower educational level [13]. Further, the type of UI may change over time [12]. The inconsistency between studies indicates a need for further insight into the condition.

We and others have characterized UI rates for women in China, but national rates in primiparous women with no UI before pregnancy have yet to be determined [2, 14, 15]. We therefore sought to estimate the rates of different types of UI in young Chinese women at first delivery and to estimate the risk factors for UI occurring in late pregnancy 37 to 42 weeks' gestation) and at 6 months postpartum.

Materials and methods

All primiparous women, ≥28 weeks' gestation with no history of UI admitted to Obstetrics and Gynecology Departments at 12 hospitals representative of the diversity of the seven administrative regions of China from September 2007 to May 2009, were recruited to complete a questionnaire. All hospitals chosen provide the same level of care and serve a similar patient base: a mix of urban and rural agricultural populations. Questionnaires were administered as previously described [15]. The study was approved by the Institutional Review Board of each hospital, and all subjects provided oral, informed consent to participate. The instrument used was the Bristol Female Lower Urinary Tract Symptoms (BFLUTS) questionnaire, which has been shown to have good validity and reliability [16]. Trained survey workers collected and recorded the data, i.e., interviewers recorded the answers to all questions. All participants use the same version of the questionnaire. The test–retest reliability was checked as follows: two survey workers collected data from the same 20 participants. Ten variables were selected randomly, and the agreement reached 95%.

Participants completed the BFLUTS questionnaire in late pregnancy (37 to 42 weeks' gestation) and at 6 weeks and 6 months postpartum during regular clinic visits. The International Continence Society definitions for types of UI were used [17]. SUI was defined as involuntary leakage on effort, exertion, sneezing, or coughing. UUI was defined as involuntary urine leakage accompanied by, or immediately preceded by, urgency. MUI was involuntary leakage associated with urgency and exertion, effort, sneezing, or coughing. All other types were classed as other UI (OUI). We used the results of the BULUF questionnaire to identify four types of UI: 9a>0, UUI; 11a>0, SUI; and both>0, MUI. If symptoms did not belong to one of the three types, it was classified as OUI. We did not count the cutoff.

Additional data collected included age, amount of exercise [frequent (at least 20 min daily) or occasional (one to

Table 1 Subject characteristics

		N=10,098
Baseline characteristics		
Age (years)		26.4±4.0
Exercise	Occasionally	4,678 (47.1%)
	Frequently	5,256 (52.9%)
Smoking	Frequently	31 (0.3%)
	Occasionally	127 (1.3%)
	No smoking	9,811 (98.4%)
Alcohol consumption	Frequently	37 (0.4%)
	Occasionally	937 (9.4%)
	No drinking	8,993 (90.2%)
Dietary fiber intake	Occasionally	827 (8.3%)
	Frequently	9,134 (91.7%)
Number of times pregnant	≥2	3,624 (35.9%)
	1	6,474 (64.1%)
Menstruation	Irregular	793 (7.9%)
	Regular	9,265 (92.1%)
Residence	Country	5,033 (49.8%)
	City	5,065 (50.2%)
Antenatal examination		
Prenatal BMI (kg/m^2)		25.2±3.7
Fundal height (cm)		33.5±4.3
Prenatal weight (kg)		64.8±10.1
Abdominal circumference (cm)		98.6±7.7
Disease history		
Gynecologic disease		163 (1.6%)
Urinary tract infection		118 (1.2%)
Pelvic surgery		
Unilateral uterine adnexectomy		27 (0.27%)
Oophorocystectomy		68 (0.67%)
Salpingotomy		13 (0.13%)
Myomectomy		23 (0.23%)
Difficult defecation		1,309 (13.5%)
Constipation		1,519 (15.0%)
Pregnancy complications		952 (9.4%)
Hypertension of pregnancy		275 (2.7%)
Gestational diabetes		165 (1.6%)
Placenta previa or placental abruption		70 (0.7%)
Childbirth		
Gestational age at delivery (weeks)		39.2±1.2
Birth weight	Mean	3,309.9±477.6 g
	>4,000 g	665 (6.6%)
	<4,000 g	9,422 (93.4%)
Mode of delivery	Vaginal	5,013 (49.6%)
	Vaginal: vacuum	52 (0.5%)
	Vaginal: forceps	89 (0.9%)
	Caesarean	4,944 (49.0%)
Perineal laceration		1,083 (10.7%)
Lateral episiotomy		3,590 (35.6%)

Missing data rates: exercise, 164 (1.62%); smoking, 129 (1.28%); alcohol consumption, 131 (1.30%); dietary fiber intake, 137 (1.36%); menstrual cycles, 40 (0.40%); BMI, 163 (1.61%); fundal height, 54 (0.53%); weight, 34 (0.34%); abdominal circumference, 55 (0.54%); gestational week of delivery, 51 (0.51%); birth weight, 11 (0.11%).

two times per week)], smoking [frequent (daily), occasional (one to two times per week), or none], alcohol consumption [frequent (every day), occasional (only at social occasions), or none], intake of dietary fiber [frequent (every day) or occasional (one to two times per week)], number of pregnancies (1 or >1), and previous menstrual history [regular (28–30 day cycles) or irregular]. All patients had an antenatal examination at 6 weeks which included prenatal body mass index (BMI) (measured as weight in kilograms per height in square meters), fundal height, prenatal weight, and abdominal circumference. Disease history included any gynecologic condition or disease (e.g., infection, endometriosis, leiomyoma) or pelvic surgery (unilateral adnexectomy, oophorocystectomy, salpingotomy, myomectomy), urinary tract infection, difficult defecating, or constipation (based on the Rome diagnostic criteria II) [18]. Pregnancy complications included hypertension or diabetes during pregnancy, placenta previa, or placental abruption. Details of childbirth were also collected and included birth weight (≥4,000 or <4,000 g), mode of delivery (vaginal or caesarean), perineal laceration, or lateral episiotomy. Operative deliveries, i.e., forceps or vacuum assisted, were classified as vaginal delivery.

Statistical analysis

A sample size of 8,200 was calculated by the following formula: $n = \frac{1.96 \times p \times (1-p)}{0.01^2}$, where p was the estimated prevalence of UI 30.9% [2] and 0.01 indicated the acceptable margin of error. The sample size was further increased by 20% for non-response or non-completed questionnaires, such that at least of 9,840 subjects were planned to be enrolled into this study.

Continuous variables were summarized by mean±standard deviation, and categorical variables were presented by number and percentage. McNemar's test was performed to compare the distribution of UI in late pregnancy and at 6 weeks and 6 months postpartum. Multinomial logistic regression models were used to investigate the independent risk factors for incidence of SUI, MUI, UUI, and OUI in late pregnancy. Binary logistic regression models were used to investigate the independent risk factors for non-recovery of UI at 6 weeks and 6 months postpartum. The results in logistic regression models were presented as odds ratio (OR) with the corresponding 95% confidence interval (CI). All variables considered statistically significant ($P<0.05$) in the corresponding univariate model were included in the multivariate model by the forward conditional stepwise method except for prenatal weight; prenatal weight was directly excluded due to its high colinearity with prenatal BMI (with the Pearson correlation coefficient obtained to 0.897 with $P<0.001$). All statistical analyses were performed using SPSS version 15.0 (SPSS Inc., Chicago, IL, USA).

Results

From September 2007 to May 2009, 10,418 pregnant females from 12 counties in the seven major areas of China were randomly enrolled and asked to complete the questionnaires during pregnancy. A total of 10,098 of them had no UI before being pregnancy and completed the questionnaires and were thus included in the analysis. Their baseline characteristics, disease history, antenatal examination data, complications in gestation, and childbirth-related data were summarized in Table 1. Mean gestational age at delivery was 39.2±1.2 weeks and 93.4% delivered of an infant <4,000 g. Half (51.0%) delivered by vaginal birth, 35.6% received a lateral episiotomy, and 10.7% experienced a perineal laceration.

In late pregnancy, 26.7% of women presented with UI, including 18.6% with SUI, 4.3% with MUI, 2.0% with UUI, and 1.8% with OUI. At 6 weeks postpartum, the prevalence

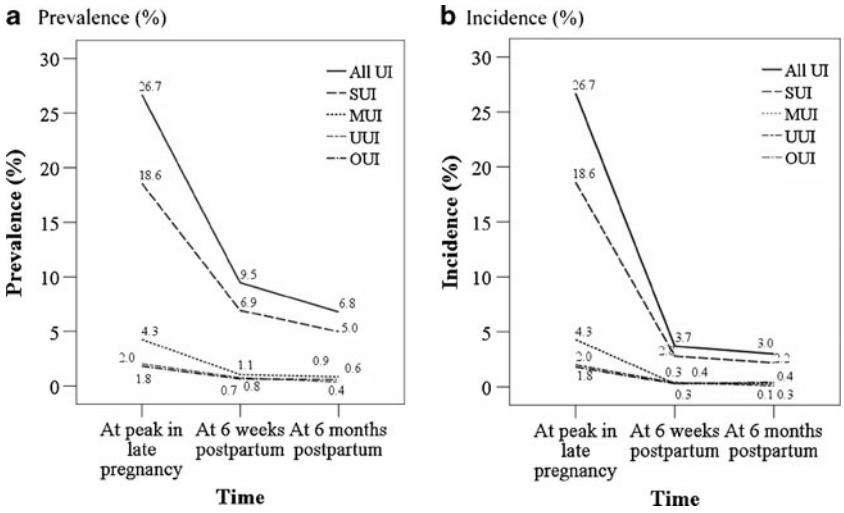

Fig. 1 **a** The prevalence at various time points was defined as the proportion of UI cases at that time among all 10,098 subjects. **b** The incidence of UI at 6 weeks postpartum was defined as the proportion of new diagnosed UI during late pregnancy to 6 weeks postpartum among the 7,402 subjects without UI at late pregnancy. The incidence of UI at 6 months postpartum was defined as the proportion of new diagnosed UI during 6 weeks to 6 months postpartum among the 9,143 subjects without UI at 6 weeks postpartum

of UI decreased to 9.5%, and at 6 months postpartum, the prevalence of UI was 6.9% (Fig. 1). For those with no UI at late pregnancy, 3.70% had newly diagnosed UI at 6 weeks postpartum, including 2.77%, 0.26%, 0.35%, and 0.32% for SUI, MUI, UUI, and other UI, respectively. For those with no UI at 6 weeks postpartum, 2.97% had newly diagnosed UI at 6 months postpartum, including 2.15%, 0.35%, 0.10%, and 0.37% for SUI, MUI, UUI, and OUI, respectively.

Table 2 presents the risk factors for UI by type. The risk factors common to SUI, MUI, and UUI were alcohol consumption and constipation. Risk factors common to SUI and MUI were age and prenatal BMI. The risk of SUI and MUI increased with maternal age. The risk of SUI increased with increased prenatal BMI, but the risk of MUI decreased with increased prenatal BMI (Table 2). Multivariate analysis revealed six independent risk factors for SUI. The risk of SUI incidence increased with maternal age (OR=1.041) and was lower for women who only occasionally exercised versus those who frequently exercised (OR=0.748). Women who drank alcohol had a higher risk of SUI than those who did not (OR=1.221). The risk of SUI increased with increasing prenatal BMI (OR=1.037) but decreased with an increase in abdominal circumference (OR=0.976). Finally, women with a history of constipation history were more likely to develop SUI in late pregnancy (OR=1.218).

Table 3 gives the risk factors associated with UI at 6 weeks and 6 months postpartum. Of the 955 women (9.5%) with UI at 6 weeks postpartum, multivariate analysis revealed ten independent risk factors for UI, after controlling for other factors. The risk of UI at 6 weeks postpartum increased by every year of increasing age (OR=1.041) and decreased by every unit increasing in prenatal BMI (OR=0.972). Women who were pregnant ≥2 times had a lower risk of UI (OR=0.784). Smoking (OR=1.681), occasional dietary fiber intake (OR=1.505), irregular menstrual cycles (OR=1.476), urinary tract infection (OR=2.004), vaginal delivery vs. caesarean (OR=2.244), delivery by forceps (OR=4.775), perineal laceration (OR=2.044), and pre-existing UI in late pregnancy (OR=8.188) were risk factors for UI at 6 weeks postpartum. Of the 687 women (6.8%) with UI at 6 months postpartum, multivariate analysis revealed five independent risk factors for UI, after controlling for other factors. Frequent exercise (OR=1.588), difficult defecation (OR=1.272), vaginal delivery (OR=1.595), delivery by forceps (OR=3.022), and pre-existing UI in late pregnancy (OR=2.233) and at 6 weeks postpartum (OR=14.770) were risk factors for UI at 6 months postpartum.

Risk factors associated with newly diagnosed UI during late pregnancy to 6 weeks postpartum and from 6 weeks postpartum to 6 months postpartum are shown in Table 4. Multivariate analysis of the 274 subjects with newly diagnosed with UI during late pregnancy to 6 weeks postpartum

Table 2 Multivariable multinomial logistic regression analysis of risk factors for SUI, UUI, MUI, and OUI in late pregnancy

		SUI		UUI		MUI		OUI	
		OR (95% CI)	*P* value	OR (95% CI)	*P* value	OR (95% CI)	*P* value	OR (95% CI)	*P* value
Age (years)		1.041 (1.027, 1.055)	<0.001[a]	0.994 (0.957, 1.033)	0.773	1.043 (1.017, 1.070)	0.001[a]	1.006 (0.967, 1.046)	0.764
Exercise	Occasionally	0.748 (0.672, 0.832)	<0.001[a]	0.884 (0.660, 1.183)	0.406	1.000 (0.816, 1.225)	0.998	0.838 (0.619, 1.134)	0.252
	Frequently	Reference		Reference		Reference		Reference	
Alcohol consumption		1.221 (1.027, 1.452)	0.024[a]	1.747 (1.155, 2.643)	0.008[a]	1.503 (1.123, 2.013)	0.006[a]	2.553 (1.746, 3.733)	<0.001[a]
Dietary fiber intake	Occasionally	0.918 (0.753, 1.120)	0.401	0.854 (0.498, 1.464)	0.566	1.649 (1.220, 2.227)	0.001[a]	1.217 (0.738, 2.008)	0.441
	Frequently	Reference		Reference		Reference		Reference	
Prenatal BMI (kg/m^2)		1.037 (1.020, 1.054)	<0.001[a]	1.009 (0.964, 1.056)	0.704	0.950 (0.921, 0.979)	<0.001[a]	0.955 (0.912, 0.999)	0.045[a]
Fundal height (cm)		1.011 (0.997, 1.025)	0.137	0.926 (0.874, 0.980)	0.008[a]	0.995 (0.964, 1.027)	0.737	1.010 (0.971, 1.050)	0.622
Abdominal circumference (cm)		0.976 (0.968, 0.985)	<0.001[a]	0.984 (0.960, 1.009)	0.215	0.985 (0.968, 1.001)	0.064	0.986 (0.963, 1.011)	0.267
Constipation		1.218 (1.055, 1.405)	0.007[a]	1.727 (1.218, 2.449)	0.002[a]	2.342 (1.871, 2.933)	<0.001[a]	1.025 (0.678, 1.549)	0.908
Complications during pregnancy		1.134 (0.953, 1.349)	0.157	1.092 (0.663, 1.796)	0.730	0.729 (0.493, 1.080)	0.115	0.472 (0.230, 0.968)	0.040[a]

A total of 291 (2.9%) subjects had missing values in the explanatory variables; thus, 9,807 (97.2%) cases were included in the analysis

[a] Indicates the corresponding variable had significant impact on the incidence of the corresponding category of UI

Table 3 Risk factors of UI at 6 weeks and 6 months postpartum

	Risk of UI at 6 weeks postpartum		Risk of UI at 6 months postpartum	
	Univariable OR (95% CI)	Multivariable[b] OR (95% CI)	Univariable OR (95% CI)	Multivariable[c] OR (95% CI)
Baseline characteristics				
Age (years)	1.030 (1.013, 1.047)[a]	1.041 (1.021, 1.061)[a]	1.018 (0.998, 1.037)	
Exercise (frequently vs. occasionally)	1.212 (1.059, 1.388)[a]		1.631 (1.388, 1.916)[a]	1.588 (1.317, 1.914)[a]
Smoking	1.797 (1.166, 2.770)[a]	1.681 (1.009, 2.801)[a]	1.013 (0.546, 1.878)	
Alcohol consumption	1.360 (1.108, 1.668)[a]		1.108 (0.861, 1.425)	
Dietary fiber intake (occasionally vs. frequently)	1.525 (1.233, 1.885)[a]	1.505 (1.185, 1.912)[a]	1.020 (0.772, 1.348)	
Prenatal BMI (kg/m^2)	0.940 (0.922, 0.958)[a]	0.972 (0.952, 0.994)[a]	0.984 (0.963, 1.005)	
Number of times pregnant (≥2 vs. 1)	0.776 (0.672, 0.897)[a]	0.784 (0.667, 0.922)[a]	0.796 (0.674, 0.941)[a]	
Rural vs. urban residence	0.878 (0.769, 1.004)		1.010 (0.865, 1.179)	
Antenatal examination				
Menstruation	1.391 (1.113, 1.738)[a]	1.476 (1.230, 1.772)[a]	0.916 (0.680, 1.234)	
Fundal height (cm)	0.971 (0.952, 0.991)[a]		1.000 (0.983, 1.019)	
Prenatal weight (kg)	0.981 (0.975, 0.988)[a]		0.995 (0.987, 1.003)	
Abdominal circumference (cm)	0.988 (0.979, 0.997)[a]		0.984 (0.973, 0.995)[a]	
Disease history				
Gynecologic disease	1.346 (0.839, 2.160)		1.610 (0.968, 2.677)	
Urinary tract infection	2.097 (1.302, 3.377)[a]	2.004 (1.164, 3.451)[a]	0.862 (0.400, 1.859)	
Pelvic surgery				
Unilateral uterine adnexectomy	0.765 (0.181, 3.236)		1.096(0.259, 4.638)	
Oophorocystectomy	2.065 (1.103, 3.866)[a]		2.382(1.212, 4.681)[a]	2.210 (0.978, 4.993)
Salpingotomy	NA		1.142(0.148, 8.794)	
Myomectomy	1.437 (0.426, 4.846)		1.306(0.305, 5.579)	
Difficult defecation	1.491 (1.249, 1.778)[a]		1.536 (1.256, 1.880)[a]	1.272 (1.001, 1.615)[a]
Constipation	1.870 (1.592, 2.195)[a]		1.550 (1.279, 1.879)[a]	
Pregnancy complications	0.704 (0.544, 0.911)[a]		0.950 (0.725, 1.244)	
Hypertension	1.088 (0.732, 1.617)		1.137 (0.723, 1.786)	
Gestational diabetes	1.102 (0.664, 1.828)		0.978 (0.528, 1.812)	
Placenta previa or placental abruption	0.427 (0.134, 1.360)		0.401 (0.098, 1.640)	
Childbirth				
Gestational age at delivery (weeks)	0.957 (0.908, 1.009)		1.015 (0.953, 1.081)	
Birth weight (≥4,000 vs. <4,000 g)	0.530 (0.376, 0.747)[a]		0.749 (0.528, 1.062)	
Mode of delivery				
Caesarean	Reference	Reference	Reference	Reference
Vaginal	2.625 (2.265, 3.042)[a]	2.244 (1.885, 2.671)[a]	3.223 (2.691, 3.861)[a]	1.595 (1.082, 2.352)[a]
Vaginal: vacuum	1.842 (0.727, 4.668)	2.499 (0.914, 6.832)	1.773 (0.547, 5.748)	0.961 (0.233, 3.961)
Vaginal: forceps	5.018 (3.005, 8.378)[a]	4.775 (2.670, 8.539)[a]	6.839 (3.942, 11.863)[a]	3.022 (1.404, 6.507)[a]
Perineal laceration	3.171 (2.692, 3.734)[a]	2.044 (1.677, 2.490)[a]	2.740 (2.265, 3.314)[a]	1.462 (0.999, 2.139)
Lateral episiotomy	1.479 (1.293, 1.693)[a]		1.929 (1.651, 2.253)[a]	1.430 (0.994, 2.057)
UI peak in late pregnancy	8.792 (7.577, 10.201)[a]	8.188 (7.015, 9.555)[a]	5.496 (4.673, 6.465)[a]	2.233 (1.840, 2.710)[a]
UI at 6 weeks postpartum			25.064 (21.022, 29.884)[a]	14.770 (12.147, 17.958)[a]

Reference group

NA OR was not available due to zero count

[a] Indicates a significant impact on the risk of UI was observed in the corresponding variable

[b] For the analysis of UI risk at 6 weeks postpartum 557 (5.5%) subjects had missing values in the explanatory variables; thus, 9,541 (94.5%) cases were included in the multivariate analysis

[c] For the analysis of UI risk at 6 months postpartum, 164 (1.6%) subjects had missing values in the explanatory variables; thus, 9,934 (98.4%) cases were included in the multivariate analysis

Table 4 Risk factors of UI during late pregnancy to 6 weeks postpartum and during 6 weeks to 6 months postpartum

	Risk of UI during late pregnancy to 6 weeks postpartum		Risk of UI during 6 weeks to 6 months postpartum	
	Univariable OR (95% CI)	Multivariable[b] OR (95% CI)	Univariable OR (95% CI)	Multivariable[c] OR (95% CI)
Baseline characteristics				
Age (years)	1.043 (1.013, 1.074)[a]	1.068 (1.036, 1.101)[a]	1.022 (0.992, 1.053)	
Exercise (frequently vs. occasionally)	1.498 (1.169, 1.920)[a]	1.583 (1.226, 2.044)[a]	1.660 (1.291, 2.135)[a]	1.539 (1.192, 1.986)[a]
Smoking	2.235 (1.074, 4.649)[a]		0.997 (0.366, 2.716)	
Alcohol consumption	1.666 (1.167, 2.379)[a]	1.598 (1.108, 2.306)[a]	1.098 (0.738, 1.634)	
Dietary fiber intake (occasionally vs. frequently)	0.822 (0.512, 1.321)		0.621 (0.361, 1.069)	
Prenatal BMI (kg/m^2)	0.957 (0.925, 0.989)[a]		1.028 (0.995, 1.062)	
Number of times pregnant (≥2 vs. 1)	0.872 (0.674, 1.127)		1.049 (0.817, 1.346)	
Rural vs. urban residence	0.903 (0.710, 1.150)		0.755 (0.592, 0.964)[a]	
Antenatal examination				
Menstruation	1.292 (0.854, 1.954)		0.751 (0.450, 1.252)	
Fundal height (cm)	0.956 (0.918, 0.995)[a]		1.001 (0.974, 1.030)	
Prenatal weight (kg)	0.987 (0.975, 0.999)[a]		1.012 (1.000, 1.024)[a]	1.022 (1.009, 1.034)[a]
Abdominal circumference (cm)	0.988 (0.972, 1.005)		0.991 (0.975, 1.008)	
Disease history				
Gynecologic disease	1.422 (0.573, 3.525)		1.438 (0.629, 3.286)	
Urinary tract infection	3.634 (1.792, 7.370)[a]	3.588 (1.704, 7.554)[a]	0.684 (0.168, 2.791)	
Pelvic surgery				
Unilateral uterine adnexectomy	NA		1.360 (0.183, 10.091)	
Oophorocystectomy	2.839 (1.005, 8.023)[a]		1.856 (0.576, 5.975)	
Salpingotomy	NA		2.724 (0.353, 21.026)	
Myomectomy	2.005 (0.261, 15.380)		NA	
Difficult defecation	1.700 (1.243, 2.326)[a]	1.629 (1.183, 2.245)[a]	1.538 (1.124, 2.104)[a]	1.444 (1.048, 1.987)[a]
Constipation	1.662 (1.230, 2.247)[a]		1.311 (0.955, 1.801)	
Pregnancy complications	0.587 (0.352, 0.979)[a]		0.986 (0.654, 1.486)	
Hypertension of pregnancy	0.675 (0.276, 1.654)		0.668 (0.273, 1.632)	
Gestational diabetes	0.880 (0.323, 2.402)		0.905 (0.332, 2.461)	
Placenta previa or placental abruption	NA		1.004 (0.244, 4.120)	
Childbirth				
Gestational age at delivery (weeks)	0.971 (0.882, 1.069)		1.104 (0.998, 1.221)	
Birth weight (≥4,000 vs. <4,000 g)	0.398 (0.196, 0.809)[a]		0.728 (0.422, 1.254)	
Mode of delivery				
Caesarean	Reference	Reference	Reference	Reference
Vaginal	3.137 (2.368, 4.157)[a]	3.033 (2.238, 4.111)[a]	2.274 (1.755, 2.948)[a]	2.309 (1.771, 3.010)[a]
Vaginal: vacuum	NA	NA	1.146 (0.156, 8.406)	1.654 (0.222, 12.307)
Vaginal: forceps	11.276 (5.639, 22.546)[a]	10.697 (5.259, 21.760)[a]	3.245 (1.156, 9.104)[a]	3.413 (1.192, 9.775)[a]
Perineal laceration	2.501 (1.845, 3.390)[a]	1.585 (1.145, 2.195)[a]	1.879 (1.346, 2.623)[a]	
Lateral episiotomy	2.097 (1.646, 2.672)[a]		1.953 (1.534, 2.487)[a]	
UI peak in late pregnancy			3.341 (2.619, 4.262)[a]	3.123 (2.442, 3.994)[a]

Reference group

NA OR was not available due to zero count

[a] Indicates a significant impact on the risk of UI was observed in the corresponding variable

[b] For the analysis of UI risk during late pregnancy to 6 weeks postpartum, 436 (5.9%) subjects had missing values in the explanatory variables; thus, 6,966 (94.1%) cases were included in the multivariate analysis

[c] For the analysis of UI risk during 6 weeks to 6 months postpartum, 422 (4.6%) subjects had missing values in the explanatory variables; thus, 8,721 (95.4%) cases were included in the multivariate analysis

Table 5 Recovery rate of late pregnancy UI

		At peak in late pregnancy			At 6 weeks postpartum		
		No UI (n=7,402)	UI (n=2,696)	P value	No UI (n=9,143)	UI (n=955)	P value
At 6 weeks postpartum	No UI	7,128 (96.3%)	2,015 (74.7%)	<0.001[a]			
	UI	274 (3.7%)	681 (25.3%)				
At 6 months postpartum	No UI	7,151 (96.6%)	2,260 (83.8%)	<0.001[a]	8,871 (97.0%)	540 (56.5%)	<0.001[a]
	UI	251 (3.4%)	436 (16.2%)		272 (3.0%)	415 (43.5%)	

[a] Indicates statistical significance level obtained by McNemar's test, i.e., a significant difference was observed between the count of those recovered from previous UI and the count of those newly diagnosed

revealed seven independent risk factors. Increasing age (OR=1.068), frequent exercise (OR=1.583), alcohol consumption (OR=1.598), urinary tract infection (OR=3.588), difficult defecation (OR=1.629), vaginal delivery (OR=3.033), delivery by forceps (OR=10.697), and lateral episiotomy (OR=1.585) were risk factors for the development of UI during late pregnancy to 6 weeks postpartum. Multivariate analysis of the 272 subjects with newly diagnosed UI from 6 weeks to 6 months postpartum revealed five independent risk factors. Increasing prenatal weight (OR=1.022), frequent exercise (OR=1.539, difficult defecation (OR=1.444), vaginal delivery (OR=2.309), delivery by forceps (OR=3.413), and UI at late pregnancy (OR=3.123) were risk factors for UI from 6 weeks to 6 months postpartum.

Of the 2,696 women who developed UI during late pregnancy, most had recovered at 6 weeks (74.7%) and 6 months (83.8%) postpartum. Significantly more women recovered from prenatal UI than were newly diagnosed (2,015 vs. 274, P<0.001; 2,260 vs. 251, P<0.001; at 6 weeks and 6 months postpartum, respectively). Of the 955 women with UI at 6 weeks postpartum, over half (56.5%) recovered by 6 months postpartum. Significantly more recovered from UI than were newly diagnosed (540 vs. 272, P<0.001) (Table 5).

To investigate the risk factors for non-recovered UI at 6 months postpartum, we conducted two multivariate logistic regression models of the 2,696 and 955 women with UI in late pregnancy and at 6 weeks postpartum, respectively. Frequent exercise, rural residence, perineal laceration, and lateral episiotomy were the common risk factors for lack of recovery from UI at 6 months postpartum (Table 6).

Discussion

In our study, prevalence of UI was 26.7% in late pregnancy, 9.5% at 6 weeks, and 6.8% at 6 months postpartum. Most cases were SUI (18.6%, 6.9%, and 5.0% in late pregnancy and at 6 weeks and 6 months postpartum, respectively). A recent meta-analysis of international studies of postpartum UI found rough consistency across studies, that is, a mean incidence of any UI of 33% at 3 months postpartum [9]. A previous study of women in China aged 20–99 years (mean, 45±16 years) reported a prevalence of 30.9% [2]. Our rates were much lower, perhaps because our population was composed primarily of young women (mean age, 26.4±4.0 years). Another study of 1,889 primiparous women at one hospital in Beijing found a prevalence of any UI, SUI, UUI, and MUI of 9.9%, 8.0%, 1.0%, and 0.9%, respectively, at 6 months [14]. A study including 5,599 primiparous women in Oregon found that timing of caesarean delivery (i.e., before labor, after labor, or after labor and pushing) did not affect its protective effect on developing UI [5]. Also, Caesarean section delivery rates are high in China, and such deliveries are associated with lower incidence of UI [5, 9]. A recent study in Iran of primiparous women reported similarly high rates of caesarean section delivery (49.1%), with concomitant lower rates of UI: 15.9% after vaginal delivery, 10.7% after elective cesarean section, and 25% after caesarean section for obstructed labor [8]. In addition, our population was composed of those free of UI before pregnancy; few population-based studies differentiated women by UI status before pregnancy [9].

In this study, as in other, the most common type of UI was SUI. A previous study of adult women in China found age, vaginal delivery, and chronic constipation to be associated with MUI [15]. UI may result from processes associated with pregnancy such as increased load or hormonal changes; BMI and larger waist may be associated with these [6, 19]. In a large, population-based Norwegian study, the prevalence of UI was more than doubled (26% to 58%) from before pregnancy to week 30 [20]. In another study of primiparous women using patient recall and stress testing, 63% leaked at some point, 8% had UI during pregnancy that resolved, but in 47% of those who developed UI during pregnancy, the incontinence had not resolved at 6 months postpartum [6]. As many of these studies did not address risk factors beyond pregnancy itself, it is difficult to make clear comparisons.

In our study, 3.7% of women with no UI in late pregnancy had newly diagnosed UI at 6 weeks postpartum and a

Table 6 Risk factors for non-recovery UI at 6 months postpartum

	Model I: non-recovery of UI from late pregnancy to 6 months postpartum (subjects with UI at late pregnancy)				Model II: non-recovery of UI from 6 weeks postpartum to 6 months postpartum (subjects with UI at 6 weeks postpartum)			
	Univariable		Multivariable		Univariable		Multivariable	
	OR (95% CI)	*P* value	OR (95% CI)	*P* value	OR (95% CI)	*P* value	OR (95% CI)	*P* value
Baseline characteristics								
Age (years)	0.972 (0.946, 0.998)	0.032[c]			0.981 (0.952, 1.012)	0.225		
Exercise (frequently vs. occasionally)	1.464 (1.183, 1.811)	<0.001[c]	1.425 (1.110, 1.829)	0.005[c]	1.603 (1.233, 2.084)	<0.001[c]	1.383 (1.051, 1.820)	0.021[c]
Smoking	0.972 (0.473, 1.995)	0.938			0.499 (0.206, 1.206)	0.122		
Alcohol consumption	0.732 (0.522, 1.026)	0.070			0.768 (0.517, 1.140)	0.190		
Dietary fiber intake (occasionally vs. frequently)	1.273 (0.900, 1.799)	0.172			0.835 (0.558, 1.251)	0.383		
Prenatal BMI[a] (kg/m^2)	0.960 (0.932, 0.988)	0.006[c]			1.013 (0.977, 1.050)	0.480		
Number of times pregnant (≥2 vs. 1)	0.706 (0.565, 0.882)	0.002[c]			0.727 (0.549, 0.963)	0.026[c]		
Rural vs. urban residence	1.687 (1.373, 2.073)	<0.001[c]	1.455 (1.140, 1.856)	0.003[c]	1.713 (1.323, 2.218)	<0.001[c]	1.541 (1.176, 2.020)	0.002[c]
Antenatal examination								
Menstruation	0.728 (0.486, 1.090)	0.123			0.668 (0.431, 1.034)	0.070		
Fundal height (cm)	1.003 (0.979, 1.028)	0.786			1.032 (0.999, 1.066)	0.055		
Prenatal weight[a] (kg)	0.987 (0.977, 0.998)	0.017[c]			0.999 (0.985, 1.012)	0.860		
Abdominal circumference (cm)	0.981 (0.966, 0.995)	0.009[c]			0.986 (0.969, 1.002)	0.088		
Disease history								
Gynecologic disease	1.038 (0.539, 1.999)	0.912			1.606 (0.659, 3.913)	0.297		
Urinary tract infection	0.385 (0.118, 1.249)	0.112			0.399 (0.145, 1.099)	0.076		
Pelvic surgery	1.416 (0.761, 2.637)	0.272			1.606 (0.659, 3.913)	0.297		
Difficult defecation	1.159 (0.887, 1.514)	0.280			1.104 (0.792, 1.539)	0.560		
Constipation	1.182 (0.917, 1.523)	0.196			0.959 (0.709, 1.297)	0.785		
Pregnancy complications	0.780 (0.535, 1.137)	0.197			1.560 (0.948, 2.567)	0.080		
Hypertension of pregnancy	1.120 (0.623, 2.015)	0.704			1.764 (0.825, 3.772)	0.143		
Gestational diabetes	0.678 (0.265, 1.733)	0.417			0.909 (0.343, 2.409)	0.848		
Placenta previa or placental abruption	NA				NA			
Childbirth								
Gestational age at delivery (weeks)	1.036 (0.954, 1.125)	0.403			1.001 (0.908, 1.104)	0.988		
Birth weight (≥4,000 vs. <4,000 g)	0.983 (0.633, 1.526)	0.938			1.870 (0.952, 3.675)	0.069		
Mode of delivery (vaginal vs. caesarean)[b]	3.723 (2.921, 4.746)	<0.001[c]			2.384 (1.761, 3.227)	<0.001[c]		
Perineal laceration	3.203 (2.499, 4.107)	<0.001[c]	2.488 (1.811, 3.418)	<0.001[c]	1.356 (1.009, 1.823)	0.044[c]	1.753 (1.246, 2.468)	0.001[c]
Lateral episiotomy	1.613 (1.312, 1.984)	<0.001[c]	2.077 (1.601, 2.693)	<0.001[c]	1.582 (1.221, 2.049)	<0.001[c]	1.953 (1.453, 2.626)	<0.001[c]
UI peak in late pregnancy	–				1.262 (0.948, 1.679)	0.111		

Table 6 (continued)

	Model I: non-recovery of UI from late pregnancy to 6months postpartum (subjects with UI at late pregnancy)				Model II: non-recovery of UI from 6weeks postpartum to 6months postpartum (subjects with UI at 6weeks postpartum)			
	Univariable		Multivariable		Univariable		Multivariable	
	OR (95% CI)	*P* value	OR (95% CI)	*P* value	OR (95% CI)	*P* value	OR (95% CI)	*P* value
UI at 6 weeks postpartum	12.001 (9.500, 15.160)	<0.001[c]	10.602 (8.318, 13.512)	<0.001[c]	–			

Model I: 18 (0.7%) subjects had missing values in the explanatory variables; thus, 2,678 (99.3%) cases were included in the multivariate analysis. Model II: 6 (0.6%) subjects had missing values in the explanatory variables; thus, 949 (99.4%) cases were included in the multivariate analysis

NA not applicable due to zero count

[a] The variable was excluded from the multivariate model I because of colinearity

[b] The variable was excluded from the multivariate model II because of colinearity

[c] Indicates a significant impact on the risk of non-recovery UI was observed in the corresponding variable

further 3.0% at 6 months. One study, which similarly compared women in late pregnancy and at 3 months postpartum, found that postpartum UI increased for those with pre-pregnancy UI, pregnancy UI, and greater pre-pregnancy BMI [21]. Another study of primiparous women in Spain found development of SUI during pregnancy the only factor independently associated with SUI at 1 year [10]. Some postpartum UI resolves, and rates at 6 months seem stable enough for this period to be considered an indication for diagnostic intervention [14]. One 12-year longitudinal study found that the prevalence of SUI and UUI increased, with SUI sometimes becoming MUI and UUI transforming into SUI [12]. Our study is in line with many others that associated vaginal birth and instrumentation with higher UI. Postpartum UI may be related to stress on pelvic muscles during pregnancy or delivery, pudendal nerve injury during labor, descent of pelvic organs, or other factors [6, 7, 19, 22]. However, sphincter tear did not always correlate with higher rates of UI at 6 months [4]. In many instance, the condition appears to resolve within 6 months of delivery, making this an ideal endpoint for determining UI associated with pregnancy or childbirth [22].

Among primiparous women, non-recovery from UI has been shown to be associated with greater BMI, larger babies, constipation before delivery, sphincter tear, and development of UI during pregnancy [4–8, 10]. While many other studies reported a similar higher incidence of UI with childbirth-associated factors (perineal laceration or lateral episiotomy) as ours, no previous studies listed exercise as associated with UI; they did not appear to track this characteristic [7–9]. The mechanism for this association is unclear, and it is possible that exercise may be a risk factor or an activity that makes the symptom of incontinence more obvious. Other studies failed to report any difference of UI rates based on rural or urban residence. Either they did not have made such distinctions (most women were recruited through hospital attendance) or differences between rural and urban settings may be less than in China [7, 9, 11]. Additionally, rural residence may indicate less frequent prenatal care [23, 24].

Though our data showed that most UI in primiparous women resolved, risk factors for the persistence of UI were identified and recognizing these factors may help to decrease the occurrence of persistent UI. A study in several types of hospitals in Australia showed that interventions incorporating physiological information, behavioral principles, and tailoring to the population can reduce the incidence of postpartum UI, particularly MUI [25]. An 8-week intervention promoting urinary continence reduced the incidence of UI from 38.4% to 31.0%, of those reporting severe UI from 17.0% to 10.1%, and increased the number of women performing pelvic floor exercises from 57.6% to 83.9%.

Our study has certain limitations. We did not examine frequency or severity of symptoms for types of UI; however,

few population-based studies have characterized frequency [9]. We found frequent exercise to be a risk factor for developing UI, but were not able to characterize the level or type of exercise associated with developing UI. All information for our study was collected by questionnaire and patient recall; results may have been different if examinations had been performed. Results may have been affected by not accounting for socioeconomic confounders, and the high caesarean section rate may limit the generalizability of the results to other populations. We did not include hospital of delivery in the model; however, all hospitals in the study provide the same level of care; thus, presumably the care patients receive will be similar. Lastly, we did not collect information regarding the second stage of labor; analysis of the length of the second stage and UI may prove valuable.

Conclusions

Rates of all types of UI in primiparous women in China are consistent with those reported elsewhere. Rural women, those who exercise frequently, and those with birth-related injuries are at increased long-term risk. These results speak to the need for effective interventions to reduce the incidence of all types of UI.

Acknowledgments The authors would like to thank the following persons for their support and cooperation in conducting the study: Professor He Jing, Women's Hospital, School of Medicine, Zhejiang University; Professor Wang Yan, Hubei Department of Gynecology, Maternal and Child Care Service Centre; Professor Chen Weifang, Department of Gynecology, Guangdong Maternal and Child Care Service Centre; Professor Xu Xin, Jilin Maternal and Child Care Service Centre; Professor Li Zhaoyi, Department of Obstetrics and Gynecology, Shanxi Maternal and Child Care Service Centre; Professor Song Yiyi, Department of Gynecology, Fujian Maternal and Child Care Service Centre; Professor Zhang Jianqing, Qinghai Redcross Hospital; Professor Duan Mingying, Jinan Maternal and Child Care Service Centre; Professor Song Ying, Kunming Maternal and Child Care Service Centre; Professor Kang Lan, Haikou Maternal and Child Care Service Centre; Professor Asai, Urumchi Maternal and Child Care Service Centre; and Professor Zhang Weiyuan, Beijing Obsterics Gynecology Hospital. This study was supported by grant 2007BAI04B95 from National 11th five-year plan scientific support programs.

Conflicts of interest None.

References

1. Brubaker L (2002) Postpartum urinary incontinence. BMJ 324:1227–8
2. Zhu L, Lang J, Liu C, Han S, Huang J, Li X (2009) The epidemiological study of women with urinary incontinence and risk factors for stress urinary incontinence in China. Menopause 16:831–6
3. Vecchioli-Scaldazza C, Morosetti C (2010) Effect of aging on urinary incontinence in woman. Arch Ital Urol Androl 82:167–71
4. Borello-France D, Burgio KL, Richter HE et al (2006) Fecal and urinary incontinence in primiparous women. Obstet Gynecol 108:863–72
5. Boyles SH, Li H, Mori T, Osterweil P, Guise J (2009) Effect of mode of delivery on the incidence of urinary incontinence in primiparous women. Obstet Gynecol 113:134–41
6. Thomason AD, Miller JM, DeLancey JO (2007) Urinary incontinence symptoms during and after pregnancy in continent and incontinent primiparas. Int Urogynecol J Pelvic Floor Dysfunct 18:147–51
7. Glazener CM, Herbison GP, MacArthur C et al (2006) New postnatal urinary incontinence: obstetric and other risk factors in primiparae. BJOG 113:208–17
8. Eftekhar T, Hajibaratali B, Ramezanzadeh F, Shariat M (2006) Postpartum evaluation of stress urinary incontinence among primiparas. Int J Gynecol Obstet 94:114–8
9. Thom DH, Rortveit G (2010) Prevalence of postpartum urinary incontinence: a systematic review. Acta Obstatricia et Gynecologica 89:1511–22
10. Diez-Itza I, Arrue M, Ibañez L, Murgiondo A, Paredes J, Sarasqueta C (2010) Factors involved in stress urinary incontinence 1 year after first delivery. Int Urogynecol J 21:439–45
11. Foldspang A, Mommsen S, Djurhuus JC (1999) Prevalent urinary incontinence as a correlate of pregnancy, vaginal childbirth, and obstetric techniques. Am J Public Health 89:209–12
12. Viktrup L, Lose G (2008) Incidence and remission of lower urinary tract symptoms during 12 years after the first delivery: a cohort study. J Urol 180:992–7
13. van Brummen HJ, Bruinse HW, van de Pol G, Heintz PM, van der Vaart CH (2006) Bothersome lower urinary tract symptoms 1 year after first delivery: prevalence and the effect of childbirth. BJU Int 98:89–95
14. Yang X, Zhang HX, Yu HY, Gao XL, Yang HX, Dong Y (2010) The prevalence of fecal incontinence and urinary incontinence in primiparous postpartum Chinese women. Eur J Obstet Gynecol Reprod Biol 152:214–7
15. Zhu L, Li L, Lang J, Xu T, Wong F (2010) Epidemiology of mixed urinary incontinence in China. Int J Gynaecol Obstet 109:55–8
16. Jackson S, Donovan J, Brookes S, Eckford S, Swithinbank L, Abrams P (1996) The Bristol Female Lower Urinary Tract Symptoms questionnaire: development and psychometric testing. Br J Urol 77:805–12
17. Abrams P, Cardozo L, Fall M et al (2002) The standardisation of terminology of lower urinary tract function: report from the Standardisation Sub-committee of the International Continence Society. Neurourol Urodyn 21:167–78
18. Thompson WG, Longstreth GF, Drossman DA, Heaton KW, Irvine EJ, Müller-Lissner SA. Functional bowel disorders and functional abdominal pain. Gut. 199;45 Suppl 2:II43-7.
19. Dietz HP, Bennett MJ (2003) The effect of childbirth on pelvic organ mobility. Obstet Gynecol 102:223–8
20. Wesnes SL, Rortveit G, Bø K, Hunskaar S (2007) Urinary incontinence during pregnancy. Obstet Gynecol 109:922–8
21. Eason E, Labrecque M, Marcoux S, Mondor M (2004) Effects of carrying a pregnancy and of method of delivery on urinary incontinence: a prospective cohort study. BMC Pregnancy Childbirth 4:4
22. Sultan AH, Kamm MA, Hudson CN (1994) Pudendal nerve damage during labour: prospective study before and after childbirth. Br J Obstet Gynaecol 101:22–8
23. Long Q, Zhang T, Hemminki E et al (2010) Utilisation, contents and costs of prenatal care under a rural health insurance (New Cooperative Medical System) in rural China: lessons from implementation. BMC Health Serv Res 10:301
24. Nwaru BI, Wu Z, Hemminki E (2011) Determinants of the use of prenatal care in rural China: the role of care content. Matern Child Health J. doi:10.1007/s10995-010-0734-0, 2010 Dec 25
25. Chiarelli P, Cockburn J (2002) Promoting urinary continence in women after delivery: randomised controlled trial. BMJ 324:1241