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TITLE PAGE

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The epidemiological profile of hysterectomy in rural Chinese women: a population-based study

RUNNING TITLE

Hysterectomy in rural China

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ABSTRACT

Objectives. Hysterectomy is one of the most common surgical procedures performed on women in developed countries, however, little is known about the epidemiology of hysterectomy in developing regions. This study seeks to evaluate the prevalence of hysterectomy and its determinants in rural China.

Methods. Questionnaires were collected from 3328 female adults aged 25-68 years in rural Anyang, China in 2009-2011. Hysterectomy status was ascertained by the gynecologist at the time of cytological test. Univariate and multivariate logistic regression analyses were performed to assess the risk factors for hysterectomy.

Results. The overall prevalence of hysterectomy was 3.31% (110/3,328). Women above the age of 40 years had a higher prevalence of hysterectomy, compared to those aged 25-40 years (4.36% *vs.* 0.45%). Obesity and history of prior pregnancy loss were associated with greater odds of hysterectomy (Adjusted OR=1.62, 95% CI, 1.01-2.60; adjusted OR=1.51, 95% CI, 1.02-2.25, respectively). Of the 75 (68.18%, 75/110) cases who provided further information on hysterectomy, 84.00% (63/75) had undergone total abdominal hysterectomy, and 70.67% (53/75) had received surgery for leiomyoma.

Conclusions. Rural Chinese women had a relatively low prevalence of hysterectomy, and the majority of reported hysterectomies were performed abdominally for leiomyoma. Hysterectomy prevalence differed significantly by age, body mass index, and history of pregnancy loss. This study expands the current understanding of the epidemiology of hysterectomy in lower-resource areas.

Keywords Hysterectomy; prevalence; risk factors; indications; surgical types

Strengths and limitations of this study

1. This is the first study to demonstrate the age-specific prevalence of and factors associated with hysterectomy in a general population in rural China; one of the main strengths is, therefore, the population-based nature and low-resource setting of this study.

2. The use of hysterectomy status data ascertained by a gynecologist in a cervical cytology screening program in rural China, where no regional or national databases were available, enabled us to estimate the prevalence and determinants of hysterectomy in this area.

3. The possibility of a response bias of participants may reduce the generalizability of our findings to a wider population.

4. The small number of hysterectomy cases may have affected the precision of our assessment of the predictors of hysterectomy.

INTRODUCTION

Hysterectomy is one of the most frequent surgical procedures performed on women in developed countries.[1] The epidemiology of hysterectomy in the female general population is of public health importance because this procedure may affect the population at risk for uterine diseases[2] and it may also be associated with significant socioeconomic and personal consequences when widely performed. Previous studies, mainly undertaken in developed regions, have shown that the prevalence of hysterectomy varies substantially by race and geographic area (4%-40%).[3-6] Education level, age at first birth, parity, number of miscarriages, and other potential risk factors have been inconsistently associated with the risk of hysterectomy.[7-9] The indications for and surgical techniques used for hysterectomy have also been found to differ across regions[1, 10-13]; however, in general, the major indication for hysterectomy is leiomyoma, and the dominant surgical type is abdominal hysterectomy.[1, 14]

Till now, the epidemiology of hysterectomy in developing countries, including China, remains largely unknown. This population-based cross-sectional study, among 3,328 rural Chinese women, seeks to: 1) assess the age-specific prevalence and determinants of hysterectomy; and 2) investigate indications for and types of hysterectomy among identified cases.

METHODS

Study population

This population-based survey was part of an ongoing esophageal cancer cohort study in rural Anyang, China.[14] The current investigation utilized a subset including 6 of the 9 target

villages involved in the parent cohort study conducted from 2009 to 2011. Eligibility criteria for subjects enrolled in this study were as follows: 1) female permanent residency in the target villages; 2) aged 25-68 years; 3) no prior diagnosis of cancer, mental disorder, or cardiovascular disease; and 4) no past history of HBV, HCV, or HIV infection. All participants in this study provided written informed consent. This study was approved by the Institutional Review Board of the Peking University School of Oncology, China. The methods were carried out in accordance with the approved guidelines.

Measurements

Briefly, hysterectomy status was ascertained by a gynecologist at the time of gynecologic examination and cytological test. Data on sociodemographic factors, cigarette smoking (defined as at least one cigarette or more per day for at least one year), alcohol consumption (defined as the consumption of Chinese liquor two or more times per week for at least one year), reproductive history, and personal health habits (e.g., genital washing before sexual intercourse) were collected through face-to-face interviews. Height and weight were measured by the interviewers.

For cases reporting a hysterectomy, information on the indications for and surgical techniques used to perform hysterectomy were also recorded. In this study, the modes of hysterectomy were divided into six categories, including total abdominal hysterectomy (involving removal of the uterus and its attached cervix through an incision in the lower abdomen), subtotal abdominal hysterectomy (involving removal of only the uterine body, leaving the cervix intact, through an incision in the lower abdomen), vaginal hysterectomy (involving removal of the

uterus via the vagina, without an abdominal incision), laparoscopic hysterectomy (involving the use of laparoscopy to perform hysterectomy), radical hysterectomy (involving removal of the uterus and resection of the ventral or lateral parametria), and other unspecified hysterectomy.

Statistical analysis

Potential risk factors that were statistically significant in univariate logistic regression analyses, together with relevant variables previously reported in literatures were included in the final multivariate models. Significant differences between groups were quantified by calculating adjusted odds ratios (OR) and 95% confidence intervals (CI). Linear regression models were used to determine whether any variables in the multivariate models were highly collinear. In this study, all variance inflation factors were below 3.0 and therefore within the acceptable range.

Statistical analyses were performed using STATA version 12.0 (STATA Corporation, College Station, TX, USA). All statistical tests were two-sided at the 0.05 significance level.

RESULTS

Participant characteristics

Of 3,849 eligible candidates, 3,328 (86.5%) were enrolled in the study (the other 521 candidates, who were more frequently of younger age, did not participate, mainly because they were employed outside of Anyang). The median age of these 3,328 participants was 43

years. Most subjects were married or cohabiting (95.00%); of the participants, 92.85% had a level of education of less than 9 years, and 88.52% were engaged in farming (Supplementary Table S1). Both cigarette smoking (0.27%) and alcohol consumption (0.21%) were uncommon. Approximately one half of the women were overweight (31.40%) or obese (18.66%), 43.27% reported menarche at the age of ≤ 15 years, 39.84% had their first birth at the age of ≤ 22 years, 37.71% had a parity > 2, 43.66% reported having a history of fetal loss, 77.34% used an intrauterine contraceptive device, 37.89% reported having had a tubal ligation, and 8.80% had a history of post-intercourse bleeding.

Prevalence and risk factors for hysterectomy

The overall prevalence of hysterectomy was 3.31% (110/3328), with the age-specific prevalence ranging from 0.25% (1/401) to 7.45% (21/282) (Figure 1). Women above the age of 40 years had a higher prevalence of hysterectomy compared to those aged 25-40 years (4.36% *vs.* 0.45%, data not shown). Obese women were found to be at greater odds of hysterectomy (Adjusted OR=1.62; 95% CI, 1.01-2.60; body mass index (BMI) ≥ 28.0 *vs.* 18.5 ≤ BMI < 24.0) (Table 1). History of prior pregnancy loss conferred a greater risk for hysterectomy (Adjusted OR=1.51; 95% CI, 1.02-2.25) (Table 1).

Indications and surgical types for hysterectomy

Of the 75 (68.18%, 75/110) cases who provided further information on hysterectomy, 70.67% (53/75) had a hysterectomy performed for leiomyoma, 10.67% (8/75) had a hysterectomy performed for dysfunctional uterine bleeding, 1.33% (1/75) had a hysterectomy performed for cervical cancer, and 6.67% (5/75) had a hysterectomy performed for other indications (Table

2). Total abdominal hysterectomy was the most common surgical technique (84.00%, 63/75), while other methods such as vaginal hysterectomy (2.67%, 2/75) and laparoscopic hysterectomy (1.33%, 1/75) each accounted for ≤ 3% of the total hysterectomies.

DISCUSSION

To our knowledge, this is the first study to demonstrate the age-specific prevalence of and factors associated with hysterectomy in a general population in rural China. Data from this study demonstrated that rural Chinese women had a low overall and age-specific prevalence of hysterectomy. Obesity and history of prior pregnancy loss were associated with greater odds of hysterectomy. The most common indication for hysterectomy was leiomyoma, and the predominant procedure performed was abdominal hysterectomy. This investigation expands our knowledge about the epidemiological profile of hysterectomy in a low-income setting.

The overall prevalence of hysterectomy (3.3%) in our study was considerably lower than previous findings from studies conducted in developed countries such as the United States, Ireland, and Australia (26.2%, 22.2%, and 22.0%, respectively)[4, 5, 15, 16] but closer to that identified in India (4-7%).[6] The low hysterectomy prevalence may be due to various reasons including poverty, poor access to medical care, and fear of surgical operations.[17] Additionally, the cultural norms associated with fertility-preserving treatment may also have contributed to the relatively lower prevalence of hysterectomy.[18, 19] The uterus, as the childbearing organ, is seen as the essence of womanhood in China. Some individuals may feel that they are no

longer women after hysterectomy. Indeed, one previous study showed that Chinese-American women who were educated in China and presumably less acculturated into the American "hysterectomy-prone" culture had a low hysterectomy rate.[20]

Although the age-specific prevalence of hysterectomy was generally lower than the previously reported rates in high-resource regions, the pattern of the age distribution of hysterectomy prevalence was consistently similar.[11] The age-specific prevalence of hysterectomy started to increase in women aged 41-45 years and thereafter remained relatively stable, which could be due to the sharp increase in hysterectomy incidence rates in this age group.[11, 21] According to previous studies, this increase may be driven by the high occurrence of uterine leiomyoma, the main indication for surgically removing the uterus, among women aged 41-49 years.[21]

In this study, prior pregnancy loss was associated with greater odds of hysterectomy; this finding is consistent with previous reports.[8, 9, 22] Complications such as uterine perforation resulting from surgical abortion may lead to the application of hysterectomy as a treatment option.[23] In addition to being a risk factor, pregnancy loss may also be a reflection of uterine dysfunction that leads to an indication for hysterectomy. Concerning BMI, a higher hysterectomy prevalence was observed in obese women in this study, confirming findings from other studies.[24] The correlation between obesity and hysterectomy can be partially explained by the fact that obesity elevates the risk of many gynecological conditions that may result in hysterectomy.[25] For instance, obesity has been reported to be associated with pelvic organ prolapse and uterine fibroids, which are common indications for hysterectomy.[26] Obese women are also more likely to develop endometrial carcinomas and pelvic inflammatory

diseases, which are less common indications for hysterectomy.[25] In terms of schooling, lower education level has been associated with a higher risk of hysterectomy, however, this association seems to vary by geographic location.[2, 12, 22, 27, 28] In this study, no correlation was found between education level and hysterectomy. Whether this null risk estimate was a true lack of association or merely due to insufficient statistical power because of the small number of hysterectomy cases and low proportion of women with high education levels included in our analysis is unclear. Further studies with larger sample sizes are warranted to validate the factors affecting hysterectomy.

Similar to reports from Taiwan[29] and Western countries,[21, 22] leiomyoma of the uterus predominated among the medical conditions leading to hysterectomy in this study population. Among women undergoing hysterectomy, abdominal hysterectomy was the most frequently performed procedure, also in agreement with most previous studies.[1, 11] However, the frequencies at which different types of hysterectomies were performed have been found to vary markedly across populations and over time, probably due to differences in healthcare resources, surgeon experience, and patient attitudes.[11, 15, 30] According to a Cochrane review of studies mainly conducted in Western countries, vaginal hysterectomy, which has become more widely performed, appeared to be superior to laparoscopic and abdominal hysterectomy for benign diseases, as it has been associated with a speedier return to normal activities due to smaller incisions.[30] However, there is limited evidence about the changes in hysterectomy rates over time and the relative superiority of hysterectomy approaches for addressing benign conditions in low-resource settings, and further research in this regard is needed.

As regional or national databases in rural China are not as readily available as they are in

developed countries, the use of hysterectomy status data ascertained by a gynecologist in a cervical cytology screening program among rural Chinese women enabled us to estimate the prevalence and determinants of hysterectomy in this area. Thus, one of the main strengths of this study is the population-based nature and low-resource setting. The limitations of this study are as follows. First, the possibility of a response bias of participants may reduce the generalizability of our findings to a wider population. Second, self-reported maternal and reproductive characteristics may be subject to recall bias. Third, the small number of hysterectomy cases may have affected the precision of our assessment of the predictors of hysterectomy. Finally, due to the cross-sectional nature of this study, a temporal relationship cannot be inferred. Despite these limitations, our study still provides baseline information on the prevalence and determinants of hysterectomy, as well as indications for and procedures used in hysterectomies in rural China.

In summary, rural Chinese women had a relatively low prevalence of hysterectomy, which were largely performed abdominally for leiomyoma. Older age, obesity and history of prior fetal loss were associated with increased risk of hysterectomy among this study population. These findings provide insights into the hysterectomy epidemiology in lower-resource areas. Further studies are needed to monitor the trend of incidence rate of hysterectomy and modes of surgery over time.

CONTRIBUTORS

YK and HC were involved in the design and conducting of the survey. YP, YL, FL, QD, XL,

ML, ZH, YL, JL, TN, CG, RX and LZ were involved in conducting the field work. FL and CZ performed the statistical analyses and wrote the manuscript text. All authors reviewed the manuscript.

ETHICAL APPROVAL AND INFORMED CONSENT

The study was approved by the Institutional Review Board of the School of Oncology, Peking University (Approval number: 2006020). All participants provided written informed consent. The methods were carried out in accordance with the approved guidelines.

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DATA SHARING

No additional data available.

CONFLICT OF INTEREST

The authors declare they have no conflict of interest with respect to this research study and paper.

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TABLES

Table 1. Prevalence of and risk factors for hysterectomy among women in rural Anyang, China, 2009-2011

Variables	Hysterectomy, No. (%)	No hysterectomy, No. (%)	Crude OR (95% CI)	Adjusted OR (95% CI)[a]
Total	110 (3.31)	3,218 (96.69)		
Age (years)				
25-40	4 (3.64)	892 (27.72)	1.00	1.00
41-56	66 (60.00)	1,527 (47.45)	9.64 (3.50, 26.53)	7.81 (2.81, 21.73)
57-68	40 (36.36)	799 (24.83)	11.16 (3.98, 31.34)	9.97 (3.35, 29.62)
Marital status				
Never married, divorced, separated or widowed	5 (4.63)	177 (5.59)	1.00	
Married or cohabiting	103 (95.37)	2,992 (94.41)	1.22 (0.49, 3.03)	
Type of employment				
Farming	101 (93.52)	2,845 (89.78)	1.00	
Non-farming	7 (6.48)	324 (10.22)	0.61 (0.28, 1.32)	
Education level				
Illiteracy (<1 year) or primary school (1-6 years)	72 (66.67)	1,814 (57.33)	1.00	
Junior high school (7-9 years)	31 (28.70)	1,173 (37.07)	0.67 (0.43, 1.02)	
Senior high school or above (>9 years)	5 (4.63)	177 (5.59)	0.71 (0.28, 1.78)	
Household annual income, RMB				
≤10,000	23 (35.94)	511 (30.42)	1.00	
10,001-29,999	17 (26.56)	534 (31.79)	0.71 (0.37, 1.34)	
≥30,000	24 (37.50)	635 (37.80)	0.84 (0.47, 1.51)	
Cigarette smoking				
Never	108 (100.00)	3,160 (99.72)	1.00	
Ever	0 (0.00)	9 (0.28)	NE	
Alcohol consumption				
Never	107 (99.07)	3,163 (99.81)	1.00	
Ever	1 (0.93)	6 (0.19)	4.93 (0.59, 41.28)	
Body mass index (BMI), Kg/m^2				
Normal weight (18.5 ≤ BMI < 24.0)	40 (36.70)	1,358 (44.42)	1.00	1.00
Overweight (24.0 ≤ BMI < 28.0)	34 (31.19)	1,011 (33.07)	1.14 (0.72, 1.82)	1.07 (0.66, 1.70)
Obese (BMI ≥ 28.0)	34 (31.19)	587 (19.20)	1.97 (1.23, 3.14)	1.62 (1.01, 2.60)
Underweight (BMI < 18.5)	1 (0.92)	101 (3.30)	0.34 (0.05, 2.47)	0.40 (0.05, 2.98)
Age (years) at menarche				
≤15	46 (42.99)	1,394 (44.45)	1.00	
16-18	45 (42.06)	1,391 (44.36)	0.98 (0.65, 1.49)	

≥19	16 (14.95)	351 (11.19)	1.38 (0.77, 2.47)	
Menstruation				
Regular	73 (68.22)	2,223 (70.80)	1.00	
Irregular	34 (31.78)	917 (29.20)	0.89 (0.59, 1.34)	
Age (years) at first birth				
≤22	53 (49.53)	1,273 (40.84)	1.00	
23-24	31 (28.97)	1,102 (35.35)	0.68 (0.43, 1.06)	
≥25	23 (21.50)	742 (23.80)	0.74 (0.45, 1.22)	
Number of pregnancies				
≤2	21 (19.44)	884 (28.22)	1.00	
3-4	53 (49.07)	1,518 (48.45)	1.47 (0.88, 2.45)	
≥5	34 (31.48)	731 (23.33)	1.96 (1.13, 3.40)	
Parity				
≤2	53 (49.07)	1,939 (61.77)	1.00	1.00
>2	55 (50.93)	1,200 (38.23)	1.68 (1.14, 2.46)	1.07 (0.68, 1.68)
History of fetal loss				
Never	50 (45.45)	1,825 (56.71)	1.00	1.00
Ever	60 (54.55)	1,393 (43.29)	1.57 (1.07, 2.30)	1.51 (1.02, 2.25)
Use of intrauterine contraceptive devices				
No	29 (26.85)	669 (21.14)	1.00	
Yes	79 (73.15)	2,495 (78.86)	0.73 (0.47, 1.13)	
Tubal ligation				
No	63 (58.33)	1,948 (61.57)	1.00	
Yes	45 (41.67)	1,216 (38.43)	1.14 (0.78, 1.69)	
History of cervicitis				
Never	91 (86.67)	2,534 (85.18)	1.00	
Ever	14 (13.33)	441 (14.82)	0.88 (0.50, 1.57)	
History of vaginitis				
Never	80 (76.19)	2,410 (80.95)	1.00	
Ever	25 (23.81)	567 (19.05)	1.33 (0.84, 2.10)	
History of pelvic inflammation				
Never	104 (96.30)	2,794 (93.92)	1.00	
Ever	4 (3.70)	181 (6.08)	0.59 (0.22, 1.63)	
History of post-intercourse bleeding				
Never	98 (91.59)	2,856 (90.96)	1.00	
Ever	9 (8.41)	284 (9.04)	0.92 (0.46, 1.85)	
Genital washing before sex				
Rare	86 (79.63)	2,329 (73.52)	1.00	
Occasional	11 (10.19)	400 (12.63)	0.74 (0.39, 1.41)	
Often	111 (10.19)	439 (13.86)	0.68 (0.36, 1.28)	

Abbreviations: OR, odds ratio; CI, confidence interval.

[a] Variables that were statistically significant in univariate analyses were included in multivariate models.

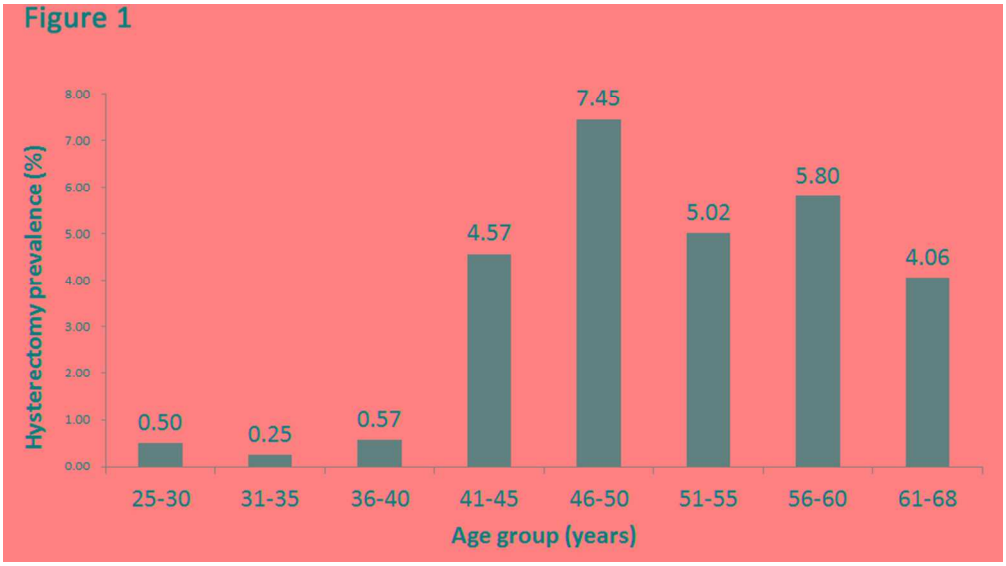
Table 2. Indications for and types of surgery among the 75 hysterectomy cases from rural Anyang, China, 2009-2011

Procedure	Leiomyoma	Dysfunctional uterine bleeding	Cervical cancer	Other	Total
	No. (%)				
Total abdominal hysterectomy	49 (92.45)	8 (100.00)	1 (25.00)	5 (50.00)	63 (84.00)
Subtotal abdominal hysterectomy	1 (1.89)	0 (0.00)	0 (0.00)	1 (10.00)	2 (2.67)
Vaginal hysterectomy	0 (0.00)	0 (0.00)	0 (0.00)	2 (20.00)	2 (2.67)
Laparoscopic hysterectomy	1 (1.89)	0 (0.00)	0 (0.00)	0 (0.00)	1 (1.33)
Radical hysterectomy	0 (0.00)	0 (0.00)	2 (50.00)	0 (0.00)	2 (2.67)
Other unspecified hysterectomy	2 (3.77)	0 (0.00)	1 (25.00)	2 (20.00)	5 (6.67)
Total	53 (100.00)	8 (100.00)	4 (100.00)	10 (100.00)	75 (100.00)

FIGURE LEGEND

Figure 1. Hysterectomy prevalence (%) by age group among 3,328 rural Chinese women, 2009-2011. The numbers of women in the 25-30, 31-35, 36-40, 41-45, 46-50, 51-55, 56-60, and 61-68 years age groups were 397, 401, 530, 635, 282, 418, 345, and 320, respectively.

Figure 1



Supporting Information

Supplementary Table S1. Selected characteristics of women included in the study of hysterectomy in rural Anyang, China, 2009-2011

Variables	No. (%)
Total	3,328 (100.00)
Age (years)	
Median (Interquartile range)	43 (36-54)
25-40	896 (26.92)
41-56	1,593 (47.87)
57-68	839 (25.21)
Marital status	
Never married, divorced, separated or widowed	182 (5.47)
Married or cohabiting	3,095 (95.00)
Unknown	51 (1.53)
Type of employment	
Farming	2,946 (88.52)
Non-farming	331 (9.95)
Unknown	51 (1.53)
Education level	
Illiteracy (<1 year) or primary school (1-6 years)	1,886 (56.67)
Junior high school (7-9 years)	1,204 (36.18)
Senior high school or above (>9 years)	182 (5.47)
Unknown	56 (1.68)
Household annual income, RMB	
≤10,000	534 (16.05)
10,001-29,999	551 (16.56)
≥30,000	659 (19.80)
Unknown	1,584 (47.60)
Cigarette smoking	
Never	3,268 (98.20)
Ever	9 (0.27)
Unknown	51 (1.53)
Alcohol consumption	
Never	3,270 (98.26)
Ever	7 (0.21)
Unknown	51 (1.53)
Body mass index (BMI), Kg/m^2	
Normal weight ($18.5 \leq BMI < 24.0$)	1,398 (42.01)
Overweight ($24.0 \leq BMI < 28.0$)	1,045 (31.40)
Obese ($BMI \geq 28.0$)	621 (18.66)

Underweight (BMI < 18.5)	102 (3.06)
Unknown	162 (4.87)
Age (years) at menarche	
≤15	1,440 (43.27)
16-18	1,436 (43.15)
≥19	367 (11.03)
Unknown	85 (2.55)
Menstruation	
Regular	2,296 (68.99)
Irregular	951 (28.58)
Unknown	81 (2.43)
Age (years) at first birth	
≤22	1,326 (39.84)
23-24	1,133 (34.04)
≥25	765 (22.99)
Unknown	104 (3.13)
Number of pregnancies	
≤2	905 (27.19)
3-4	1,571 (47.21)
≥5	765 (22.99)
Unknown	87 (2.61)
Parity	
≤ 2	1,992 (59.86)
> 2	1,255 (37.71)
Unknown	81 (2.43)
History of fetal loss	
Never	1,875 (56.34)
Ever	1,453 (43.66)
Unknown	
Use of intrauterine contraceptive device	
No	698 (20.97)
Yes	2,574 (77.34)
Unknown	56 (1.68)
Tubal ligation	
No	2,011 (60.43)
Yes	1,261 (37.89)
Unknown	56 (1.68)
History of cervicitis	
Never	2,625 (78.88)
Ever	455 (13.67)
Unknown	248 (7.45)
History of vaginitis	
Never	2,490 (74.82)
Ever	592 (17.79)

Unknown	246 (7.39)
History of pelvic inflammation	
Never	2,898 (87.08)
Ever	185 (5.56)
Unknown	245 (7.36)
History of post-intercourse bleeding	
Never	2,954 (88.76)
Ever	293 (8.80)
Unknown	81 (2.43)
Genital washing before sex	
Rare	2,415 (72.57)
Occasional	411 (12.35)
Often	450 (13.52)
Unknown	52 (1.56)

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TITLE PAGE

TITLE

The epidemiological profile of hysterectomy in rural Chinese women: a population-based study

RUNNING TITLE

Hysterectomy in rural China

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ABSTRACT

Objectives. Hysterectomy is one of the most common surgical procedures performed on women in developed countries, however, little is known about the epidemiology of hysterectomy in developing regions. This study seeks to evaluate the prevalence of hysterectomy and its risk factors in rural China.

Methods. Questionnaires were collected from 3328 female adults aged 25-69 years in rural Anyang, China in 2009-2011. Hysterectomy status was ascertained by the gynecologist at the time of cytological test. Univariate and multivariate regression analyses were performed to assess the risk factors for hysterectomy.

Results. The overall prevalence of hysterectomy was 3.31% (110/3,328). Women above the age of 40 years had a higher prevalence of prior hysterectomy, compared to those aged 25-39 years (5.01% *vs.* 0.33%). Obesity was marginally related with a higher risk of hysterectomy (Adjusted OR=1.59; 95% CI, 0.99-2.56; body mass index (BMI) $\geq$ 28.0 vs. 18.5 $\leq$ BMI $<$ 24.0). History of prior pregnancy loss conferred a greater risk for hysterectomy (Adjusted OR=1.51; 95% CI, 1.02-2.23). Of the 75 (68.18%, 75/110) cases who provided further information on hysterectomy, 84.00% (63/75) had undergone total abdominal hysterectomy, and 70.67% (53/75) had received surgery for leiomyoma.

Conclusions. Rural Chinese women had a relatively low prevalence of hysterectomy, and the majority of reported hysterectomies were performed abdominally for leiomyoma. Hysterectomy prevalence differed significantly by age, body mass index, and history of pregnancy loss. This study expands the current understanding of the epidemiology of

hysterectomy in lower-resource areas.

Keywords Hysterectomy; prevalence; risk factors; indications; surgical types

Strengths and limitations of this study

1. This is the first study to demonstrate the prevalence of and factors associated with hysterectomy in a general population in rural China; one of the main strengths is, therefore, the population-based nature and low-resource setting of this study.

2. The use of hysterectomy status data ascertained by a gynecologist in a cervical cytology screening program in rural China, where no regional or national databases were available, enabled us to estimate the prevalence and risk factors of hysterectomy in this area.

3. The possibility of a response bias of participants may reduce the generalizability of our findings to a wider population.

4. The small number of hysterectomy cases may have affected the precision of our assessment of the predictors of hysterectomy.

INTRODUCTION

Hysterectomy is one of the most frequent surgical procedures performed on women in developed countries.[1] The epidemiology of hysterectomy in the female general population is of public health importance because this procedure may affect the population at risk for uterine diseases[2] and it may also be associated with significant socioeconomic and personal consequences when widely performed. Previous studies, mainly undertaken in developed regions, have shown that the prevalence of hysterectomy varies substantially by race and geographic area (4%-40%).[3-7] Education level, age at first birth, parity, number of miscarriages, and other potential risk factors have been inconsistently associated with the risk of hysterectomy.[5, 8-10] The indications for and surgical techniques used for hysterectomy have also been found to differ across regions[1, 4, 11-13]; however, in general, the major indication for hysterectomy is leiomyoma, and the dominant surgical type is abdominal hysterectomy.[1, 14]

Till now, the epidemiology of hysterectomy in developing countries, including China, remains largely unknown. This population-based cross-sectional study, among 3,328 rural Chinese women, seeks to: 1) assess the prevalence and risk factors of hysterectomy; and 2) investigate indications for and types of hysterectomy among identified cases.

METHODS

Study population

This population-based survey was part of an ongoing esophageal cancer cohort study in rural Anyang, China.[14] The current investigation utilized a subset including 6 of the 9 target

villages which were cluster-sampled in the parent cohort study conducted from 2009 to 2011. Eligibility criteria for subjects enrolled in this study were as follows: 1) female permanent residency in the target villages (registered in the China's hukou system); 2) aged 25-69 years; 3) no prior diagnosis of cancer (9 residents were excluded before enrollment because of self-reported history of cancer including 1 with cervical cancer), mental disorder, or cardiovascular disease; and 4) no past history of HBV, HCV, or HIV infection. All participants in this study provided written informed consent. This study was approved by the Institutional Review Board of the Peking University School of Oncology, China. The methods were carried out in accordance with the approved guidelines.

Measurements

Briefly, hysterectomy status was ascertained by a gynecologist at the time of gynecologic examination and cytological test. Data on sociodemographic factors, cigarette smoking (defined as at least one cigarette or more per day for at least one year), alcohol consumption (defined as the consumption of Chinese liquor two or more times per week for at least one year), reproductive history, and personal health habits (e.g., genital washing before sexual intercourse) were collected through face-to-face interviews before gynecologic tests on the same day. Height and weight were measured by the interviewers.

For cases reporting a hysterectomy, the time of the procedure along with the information on the indications for and surgical techniques used to perform hysterectomy were also recorded. In this study, the modes of hysterectomy were divided into six categories, including total abdominal hysterectomy (involving removal of the uterus and its attached cervix through an

incision in the lower abdomen), subtotal abdominal hysterectomy (involving removal of only the uterine body, leaving the cervix intact, through an incision in the lower abdomen), vaginal hysterectomy (involving removal of the uterus via the vagina, without an abdominal incision), laparoscopic hysterectomy (involving the use of laparoscopy to perform hysterectomy), radical hysterectomy (involving removal of the uterus and resection of the ventral or lateral parametria), and other unspecified hysterectomy.

Statistical analysis

Prevalence estimates along with 95% confidence intervals (CI) were estimated using a null linear regression model implemented with the Generalized Estimating Equation (GEE) with a robust sandwich estimator of covariance to adjust for intracluster correlation.[15] The China 2010 Population Census data and the World Health Organization world standard population data were used for calculating the adjusted prevalence of prior hysterectomy.[16] Potential risk factors that were statistically significant in univariate GEE regression analyses were entered in the final multivariate GEE regression models. Significant differences between groups were quantified by calculating adjusted odds ratios (OR) and 95% confidence intervals (CI). Tests for linear trends were performed by treating ordered categorical variables as continuous variables in the GEE regression analyses. Linear regression models were used to determine whether any variables in the multivariate models were highly collinear. In this study, all variance inflation factors were below 3.0 and therefore within the acceptable range.

Statistical analyses were performed using STATA version 12.0 (STATA Corporation, College Station, TX, USA). All statistical tests were two-sided at the 0.05 significance level.

RESULTS

Participant characteristics

Of 3,849 eligible candidates, 3,328 (86.5%) were enrolled in the study (the other 521 candidates, who were more frequently of younger age, did not participate, mainly because they were employed outside of Anyang). The median age of these 3,328 participants was 43 years. Most subjects were married or cohabiting (95.00%); of the participants, 92.85% had a level of education of less than 9 years, and 88.52% were engaged in farming (Supplementary Table S1). Both cigarette smoking (0.27%) and alcohol consumption (0.21%) were uncommon. Approximately one half of the women were overweight (31.40%) or obese (18.66%), 43.27% reported menarche at the age of ≤ 15 years, 39.84% had their first birth at the age of ≤ 22 years, 37.71% had a parity > 2, 43.66% reported having a history of fetal loss, 77.34% used an intrauterine contraceptive device, 37.89% reported having had a tubal ligation, and 8.80% had a history of post-intercourse bleeding.

Prevalence and risk factors for hysterectomy

The overall prevalence of prior hysterectomy was 3.31% (110/3328, 95% CI: 2.49-4.12). Adjusted estimates of prevalence standardized by the age structure of the female population of China's 2010 Census and by the age distribution of the World Health Organization world standard population of 2001 were 3.21% and 3.03% respectively. Figure 1 shows the prevalence of prior hysterectomy according to five-year age groups. Among women age 25-39, 0.33% (4/1214) had no uterus (age25-29: 0.32%; age 30-34: 0.52%; age 35-39: 0.19%).

The percentage rose to 7.22% (27/374) among women age 45-49. After age 50, the prevalence of prior hysterectomy declined somewhat (Figure 1). Women above the age of 40 years had a higher prevalence of prior hysterectomy compared to those aged 25-39 years (5.01 % *vs.* 0.33%, data not shown). Obesity was marginally related with a higher risk of hysterectomy (Adjusted OR=1.59; 95% CI, 0.99-2.56; body mass index (BMI) ≥ 28.0 *vs.* 18.5 ≤ BMI < 24.0) (Table 1). History of prior pregnancy loss conferred a greater risk for hysterectomy (Adjusted OR=1.51; 95% CI, 1.02-2.23) (Table 1).

Indications and surgical types for hysterectomy

A total of 75 (68.18%, 75/110) cases provided further information on hysterectomy, with mean age at time of hysterectomy of 44 years (standard deviation: 7.6 years; range: 27-66 years) (Supplementary Figure S1). Of these 75 cases, 70.67% (53/75) had a hysterectomy performed for leiomyoma, 10.67% (8/75) had a hysterectomy performed for dysfunctional uterine bleeding, 1.33% (1/75) had a hysterectomy performed for cervical cancer, and 6.67% (5/75) had a hysterectomy performed for other indications (Table 2). Total abdominal hysterectomy was the most common surgical technique (84.00%, 63/75), while other methods such as vaginal hysterectomy (2.67%, 2/75) and laparoscopic hysterectomy (1.33%, 1/75) each accounted for ≤ 3% of the total hysterectomies.

DISCUSSION

To our knowledge, this is the first study to demonstrate the prevalence of and factors associated with hysterectomy in a general population in rural China. Data from this study

demonstrated that rural Chinese women had a low prevalence of hysterectomy. Obesity and history of prior pregnancy loss were associated with greater odds of hysterectomy. The most common indication for hysterectomy was leiomyoma, and the predominant procedure performed was abdominal hysterectomy. This investigation expands our knowledge about the epidemiological profile of hysterectomy in a low-income setting.

The overall prevalence of hysterectomy (3.3%) in our study was considerably lower than previous findings from studies conducted in developed countries such as the United States (26.2%), Ireland (22.2%), and Australia (22.0%)[17-20], but closer to that identified in Taiwan (8.8%) and Singapore (7.5%).[21, 22] Data on hysterectomy is limited in developing settings. Our estimated prevalence was in the lower range reported by community-based studies from low- and middle-income countries such as India, El Salvador and Jordan (1.7%-9.8%)[3, 23-30], similar to percentage reported among women textile workers in Shanghai, China (3.9%).[31] The low hysterectomy prevalence in this study population may be due to various reasons including limited availability of gynecology services, poor access to public/private sectors, and fear of surgical operations. Additionally, low affordability of medical care can be another explanation for the low prevalence. Based on data of China's National Health Survey in 2003, more than one-third of those who did not seek medical care while sick and over two-thirds of those who refused hospitalization after professional referral reported 'excessive cost' as the major factor influencing their decisions.[32] The cultural norms associated with fertility-preserving treatment may also have contributed to the relatively lower prevalence of hysterectomy.[7, 33] The uterus, as the childbearing organ, is seen as the essence of womanhood in China. Some individuals may feel that they are no longer women after hysterectomy. Indeed, one previous study

showed that Chinese-American women who were educated in China and presumably less acculturated into the American "hysterectomy-prone" culture had a low hysterectomy rate.[34] Although the overall prevalence of hysterectomy was generally lower than the previously reported rates in high-resource regions, the pattern of the age distribution of prior hysterectomy prevalence was consistently similar.[4] The percentage of prior hysterectomy started to increase in women aged 40-49 years and thereafter remained relatively stable, which could be due to the sharp increase in hysterectomy incidence rates in this age group.[4, 35] In support of this reasoning, we observed that the average age at hysterectomy was 44 years and more than one-half of all hysterectomies were done in women age 40-49 in this study. According to previous investigations, this increase may be driven by the high occurrence of uterine leiomyoma, the main indication for surgically removing the uterus, among women aged 40-49 years.[35] Approximately one quarter of hysterectomies were performed in women younger than 40 years of age in this study. Evidence on the long-term side effects of hysterectomy suggests that hysterectomies, especially those performed at young age, are associated with earlier onset of menopause and higher risk of cardiovascular disease, urinary incontinence and problems with sexual function.[36-39] Research is required across China to monitor trends and track long-term health effects of hysterectomy.

In terms of predictors for hysterectomy, it should be noted that data on sociodemographic factors and behavioral characteristics as well as information about BMI status were only gathered at the time of interview, hence whether there was any change in these questionnaire data before or after a hysterectomy, if performed, is unknown. The following discussion was based on the assumption that the information of aforementioned variables remained

unchanged before the interview. In this study, prior pregnancy loss was associated with greater odds of hysterectomy; this finding is consistent with previous reports.[5, 9, 40] Induced abortions have been commonly used in China since the 1970s as part of the national family planning programme. According to surveys conducted in China, approximately 50% of women had prior abortions, primarily aiming to limit family size.[41, 42] Complications such as uterine perforation resulting from surgical abortion may lead to the application of hysterectomy as a treatment option.[43] In addition to being a risk factor, pregnancy loss may also be a reflection of uterine dysfunction that leads to an indication for hysterectomy. In terms of schooling, lower education level has been associated with a higher risk of hysterectomy, however, this association seems to vary by geographic location.[2, 12, 40, 44, 45] In this study, no correlation was found between education level and hysterectomy. Whether this null risk estimate was a true lack of association or merely due to insufficient statistical power because of the small number of hysterectomy cases and low proportion of women with high education levels included in our analysis is unclear. Concerning BMI, a higher hysterectomy frequency was observed in obese women in this study, confirming findings from other studies.[46] The correlation between obesity and hysterectomy can be partially explained by the fact that obesity elevates the risk of many gynecological conditions that may result in hysterectomy.[47] For instance, obesity has been reported to be associated with pelvic organ prolapse and uterine fibroids, which are common indications for hysterectomy.[48] Obese women are also more likely to develop endometrial carcinomas and pelvic inflammatory diseases, which are less common indications for hysterectomy.[47] Again, however, whether BMI status varied with undergoing hysterectomy is not determinable from the data at hand.

Further studies with larger sample sizes are warranted to validate the factors affecting hysterectomy.

Similar to reports from Taiwan[6] and Western countries,[35, 40] leiomyoma of the uterus predominated among the medical conditions leading to hysterectomy in this study population. Among women undergoing hysterectomy, abdominal hysterectomy was the most frequently performed procedure, also in agreement with most previous studies.[1, 4] However, the frequencies at which different types of hysterectomies were performed have been found to vary markedly across populations and over time, probably due to differences in healthcare resources, surgeon experience, and patient attitudes.[4, 17, 49] According to a Cochrane review of studies mainly conducted in Western countries, vaginal hysterectomy, which has become more widely performed, appeared to be superior to laparoscopic and abdominal hysterectomy for benign diseases, as it has been associated with a speedier return to normal activities due to smaller incisions.[49] However, there is limited evidence about the changes in hysterectomy rates over time and the relative superiority of hysterectomy approaches for addressing benign conditions in low-resource settings, and further research in this regard is needed.

As regional or national databases in rural China are not as readily available as they are in developed countries, the use of hysterectomy status data ascertained by a gynecologist in a cervical cytology screening program among rural Chinese women enabled us to evaluate the prevalence and predictors of hysterectomy in this area. Thus, one of the main strengths of this study is the population-based nature and low-resource setting. The limitations of this study are as follows. First, the possibility of a selection bias (e.g. bias introduced by exclusion of individuals with a prior history of cervical cancer) and response bias of participants may

reduce the generalizability of our findings to a wider population. Second, self-reported maternal and reproductive characteristics may be subject to recall bias. Third, the small number of hysterectomy cases may have affected the precision of our assessment of the predictors of hysterectomy. Finally, due to the cross-sectional nature of this study, a temporal relationship cannot be inferred. Despite these limitations, our study still provides baseline information on the prevalence and predictors of hysterectomy, as well as indications for and procedures used in hysterectomies in rural China.

In summary, rural Chinese women had a relatively low prevalence of hysterectomy, which were largely performed abdominally for leiomyoma. Older age, obesity and history of prior fetal loss were associated with increased risk of hysterectomy among this study population. These findings provide insights into the hysterectomy epidemiology in lower-resource areas. Further studies are needed to monitor the trend of incidence rate of hysterectomy and modes of surgery over time.

CONTRIBUTORS

YK and HC were involved in the design and conducting of the survey. YP, YL, FL, QD, XL, ML, ZH, YL, JL, TN, CG, RX and LZ were involved in conducting the field work. FL and CZ performed the statistical analyses and wrote the manuscript text. All authors reviewed the manuscript.

ETHICAL APPROVAL AND INFORMED CONSENT

The study was approved by the Institutional Review Board of the School of Oncology, Peking University (Approval number: 2006020). All participants provided written informed consent. The methods were carried out in accordance with the approved guidelines.

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DATA SHARING

No additional data available.

CONFLICT OF INTEREST

The authors declare they have no conflict of interest with respect to this research study and paper.

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TABLES

Table 1. Prevalence of and risk factors for hysterectomy among women in rural Anyang, China, 2009-2011

Variables	Hysterectomy, No. (%)	No hysterectomy, No. (%)	Crude OR (95% CI)	Adjusted OR (95% CI)[a]	*P* value[a]
Total	110 (3.31)	3,218 (96.69)			
Age (years)					
25-40	4 (3.64)	892 (27.72)	1.00	1.00	
41-56	66 (60.00)	1,527 (47.45)	9.52 (3.53, 25.64)	7.82 (2.87, 21.31)	<0.001
57-69	40 (36.36)	799 (24.83)	11.04 (4.02, 30.31)	10.10 (3.48, 29.32)	<0.001
P_{trend}[b]			<0.001	<0.001	
Marital status					
Never married, divorced, separated or widowed	5 (4.63)	177 (5.59)	1.00		
Married or cohabiting	103 (95.37)	2,992 (94.41)	1.24 (0.50, 3.12)		
Type of employment					
Farming	101 (93.52)	2,845 (89.78)	1.00		
Non-farming	7 (6.48)	324 (10.22)	0.61 (0.28, 1.32)		
Education level					
Illiteracy (<1 year) or primary school (1-6 years)	72 (66.67)	1,814 (57.33)	1.00		
Junior high school (7-9 years)	31 (28.70)	1,173 (37.07)	0.67 (0.44, 1.03)		
Senior high school or above (>9 years)	5 (4.63)	177 (5.59)	0.71 (0.28, 1.79)		
P_{trend}[b]			0.085		
Household annual income, RMB					
≤10,000	23 (35.94)	511 (30.42)	1.00		
10,001-29,999	17 (26.56)	534 (31.79)	0.71 (0.37, 1.34)		
≥30,000	24 (37.50)	635 (37.80)	0.86 (0.48, 1.54)		
P_{trend}[b]			0.643		
Cigarette smoking					
Never	108 (100.00)	3,160 (99.72)	1.00		

Ever	0 (0.00)	9 (0.28)	NE		
Alcohol consumption					
Never	107 (99.07)	3,163 (99.81)	1.00		
Ever	1 (0.93)	6 (0.19)	4.89 (0.58, 41.33)		
Body mass index (BMI), Kg/m^2					
Normal weight (18.5 ≤ BMI < 24.0)	40 (36.70)	1,358 (44.42)	1.00	1.00	
Overweight (24.0 ≤ BMI < 28.0)	34 (31.19)	1,011 (33.07)	1.15 (0.72, 1.84)	1.06 (0.66, 1.70)	0.815
Obese (BMI ≥ 28.0)	34 (31.19)	587 (19.20)	2.01 (1.26, 3.22)	1.59 (0.99, 2.56)	0.054
Underweight (BMI < 18.5)	1 (0.92)	101 (3.30)	0.35 (0.05, 2.51)	0.38 (0.05, 2.94)	0.355
P_{trend}[b]			0.061	0.223	
Age (years) at menarche					
≤15	46 (42.99)	1,394 (44.45)	1.00		
16-18	45 (42.06)	1,391 (44.36)	0.98 (0.64, 1.49)		
≥19	16 (14.95)	351 (11.19)	1.38 (0.77, 2.46)		
P_{trend}[b]			0.437		
Menstruation					
Regular	73 (68.22)	2,223 (70.80)	1.00		
Irregular	34 (31.78)	917 (29.20)	0.88 (0.58, 1.34)		
Age (years) at first birth					
≤22	53 (49.53)	1,273 (40.84)	1.00		
23-24	31 (28.97)	1,102 (35.35)	0.68 (0.43, 1.07)		
≥25	23 (21.50)	742 (23.80)	0.75 (0.46, 1.23)		
P_{trend}[b]			0.166		
Parity					
≤2	53 (49.07)	1,939 (61.77)	1.00	1.00	
>2	55 (50.93)	1,200 (38.23)	1.72 (1.16, 2.53)	1.05 (0.67, 1.64)	0.842
History of fetal loss					
Never	50 (45.45)	1,825 (56.71)	1.00	1.00	
Ever	60 (54.55)	1,393 (43.29)	1.56 (1.06, 2.30)	1.51 (1.02, 2.23)	0.038

Use of intrauterine contraceptive devices			
No	29 (26.85)	669 (21.14)	1.00
Yes	79 (73.15)	2,495 (78.86)	0.72 (0.47, 1.11)
Tubal ligation			
No	63 (58.33)	1,948 (61.57)	1.00
Yes	45 (41.67)	1,216 (38.43)	1.15 (0.78, 1.69)
History of cervicitis			
Never	91 (86.67)	2,534 (85.18)	1.00
Ever	14 (13.33)	441 (14.82)	0.89 (0.50, 1.58)
History of vaginitis			
Never	80 (76.19)	2,410 (80.95)	1.00
Ever	25 (23.81)	567 (19.05)	1.32 (0.83, 2.09)
History of pelvic inflammation			
Never	104 (96.30)	2,794 (93.92)	1.00
Ever	4 (3.70)	181 (6.08)	0.59 (0.21, 1.63)
History of post-intercourse bleeding			
Never	98 (91.59)	2,856 (90.96)	1.00
Ever	9 (8.41)	284 (9.04)	0.92 (0.46, 1.84)
Genital washing before sex			
Rare	86 (79.63)	2,329 (73.52)	1.00
Occasional	11 (10.19)	400 (12.63)	0.75 (0.39, 1.41)
Often	111 (10.19)	439 (13.86)	0.67 (0.36, 1.28)
P_{trend} [b]			0.162

Abbreviations: OR, odds ratio; CI, confidence interval; GEE, Generalized Estimating Equation; NE, not estimable.

[a] Variables that were statistically significant in univariate GEE regression analyses were included in multivariate models. Adjusted ORs, 95% CIs and *P* values were calculated by multivariate GEE regression model including age group, body mass index, parity, and history of fetal loss.

[b] *P* values for trend were calculated by GEE regression analyses, treating categorical variables as continuous variables.

Table 2. Indications for and types of surgery among the 75 hysterectomy cases from rural Anyang, China, 2009-2011

Procedure	Leiomyoma	Dysfunctional uterine bleeding	Cervical cancer	Other	Total
	No. (%)				
Total abdominal hysterectomy	49 (92.45)	8 (100.00)	1 (25.00)	5 (50.00)	63 (84.00)
Subtotal abdominal hysterectomy	1 (1.89)	0 (0.00)	0 (0.00)	1 (10.00)	2 (2.67)
Vaginal hysterectomy	0 (0.00)	0 (0.00)	0 (0.00)	2 (20.00)	2 (2.67)
Laparoscopic hysterectomy	1 (1.89)	0 (0.00)	0 (0.00)	0 (0.00)	1 (1.33)
Radical hysterectomy	0 (0.00)	0 (0.00)	2 (50.00)	0 (0.00)	2 (2.67)
Other unspecified hysterectomy	2 (3.77)	0 (0.00)	1 (25.00)	2 (20.00)	5 (6.67)
Total	53 (100.00)	8 (100.00)	4 (100.00)	10 (100.00)	75 (100.00)

FIGURE LEGEND

Figure 1. The prevalence of prior hysterectomy (%) according to five-year age groups among 3,328 rural Chinese women, 2009-2011. The numbers of women in the 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, and 65-69 years age groups were 313, 384, 517, 633, 374, 344, 365, 330, and 68 respectively.

Supplementary Figure S1. Age at time of hysterectomy among 75 cases with detailed information on hysterectomy

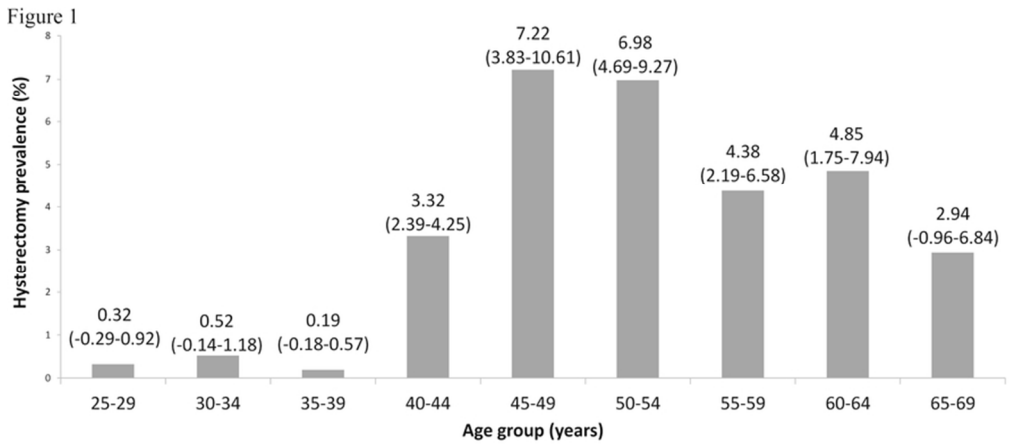


Figure 1. The prevalence of prior hysterectomy (%) according to five-year age groups among 3,328 rural Chinese women, 2009-2011. The numbers of women in the 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, and 65-69 years age groups were 313, 384, 517, 633, 374, 344, 365, 330, and 68 respectively.

74x32mm (300 x 300 DPI)

Supporting Information

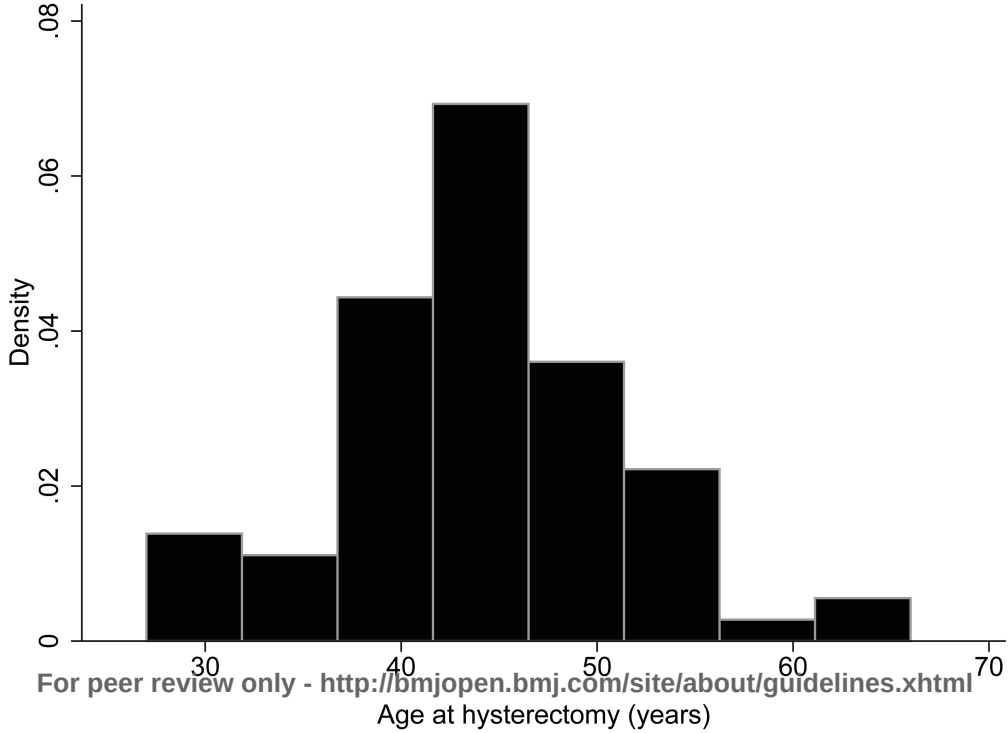
Supplementary Table S1. Selected characteristics of women included in the study of hysterectomy in rural Anyang, China, 2009-2011

Variables	No. (%)
Total	3,328 (100.00)
Age (years)	
Median (Interquartile range)	43 (36-54)
25-40	896 (26.92)
41-56	1,593 (47.87)
57-69	839 (25.21)
Marital status	
Never married, divorced, separated or widowed	182 (5.47)
Married or cohabiting	3,095 (95.00)
Unknown	51 (1.53)
Type of employment	
Farming	2,946 (88.52)
Non-farming	331 (9.95)
Unknown	51 (1.53)
Education level	
Illiteracy (<1 year) or primary school (1-6 years)	1,886 (56.67)
Junior high school (7-9 years)	1,204 (36.18)
Senior high school or above (>9 years)	182 (5.47)
Unknown	56 (1.68)
Household annual income, RMB	
≤10,000	534 (16.05)
10,001-29,999	551 (16.56)
≥30,000	659 (19.80)
Unknown	1,584 (47.60)
Cigarette smoking	
Never	3,268 (98.20)
Ever	9 (0.27)
Unknown	51 (1.53)
Alcohol consumption	
Never	3,270 (98.26)
Ever	7 (0.21)
Unknown	51 (1.53)
Body mass index (BMI), Kg/m^2	
Normal weight ($18.5 \leq BMI < 24.0$)	1,398 (42.01)
Overweight ($24.0 \leq BMI < 28.0$)	1,045 (31.40)
Obese ($BMI \geq 28.0$)	621 (18.66)

Underweight (BMI < 18.5)	102 (3.06)
Unknown	162 (4.87)
Age (years) at menarche	
≤15	1,440 (43.27)
16-18	1,436 (43.15)
≥19	367 (11.03)
Unknown	85 (2.55)
Menstruation	
Regular	2,296 (68.99)
Irregular	951 (28.58)
Unknown	81 (2.43)
Age (years) at first birth	
≤22	1,326 (39.84)
23-24	1,133 (34.04)
≥25	765 (22.99)
Unknown	104 (3.13)
Parity	
≤ 2	1,992 (59.86)
> 2	1,255 (37.71)
Unknown	81 (2.43)
History of fetal loss	
Never	1,875 (56.34)
Ever	1,453 (43.66)
Unknown	
Use of intrauterine contraceptive device	
No	698 (20.97)
Yes	2,574 (77.34)
Unknown	56 (1.68)
Tubal ligation	
No	2,011 (60.43)
Yes	1,261 (37.89)
Unknown	56 (1.68)
History of cervicitis	
Never	2,625 (78.88)
Ever	455 (13.67)
Unknown	248 (7.45)
History of vaginitis	
Never	2,490 (74.82)
Ever	592 (17.79)
Unknown	246 (7.39)
History of pelvic inflammation	
Never	2,898 (87.08)
Ever	185 (5.56)
Unknown	245 (7.36)

History of post-intercourse bleeding	
Never	2,954 (88.76)
Ever	293 (8.80)
Unknown	81 (2.43)
Genital washing before sex	
Rare	2,415 (72.57)
Occasional	411 (12.35)
Often	450 (13.52)
Unknown	52 (1.56)

Supplementary Figure S1



STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3,4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5,6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5,6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	5,6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6,7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	7
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8,9
		(b) Give reasons for non-participation at each stage	8,9
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8,9
		(b) Indicate number of participants with missing data for each variable of interest	8,9
Outcome data	15*	Report numbers of outcome events or summary measures	8,9
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8,9

		(*b*) Report category boundaries when continuous variables were categorized	21,22,23
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	9,10
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13,14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11,12,13
Generalisability	21	Discuss the generalisability (external validity) of the study results	13,14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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The epidemiological profile of hysterectomy in rural Chinese women: a population-based study

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Secondary Subject Heading:	Obstetrics and gynaecology
Keywords:	GYNAECOLOGY, Hysterectomy, Prevalence, EPIDEMIOLOGY

TITLE PAGE

TITLE

The epidemiological profile of hysterectomy in rural Chinese women: a population-based study

RUNNING TITLE

Hysterectomy in rural China

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ABSTRACT

Objectives. Hysterectomy is one of the most common surgical procedures performed on women in developed countries, however, little is known about the epidemiology of hysterectomy in developing regions. This study seeks to evaluate the prevalence of hysterectomy and its risk factors in rural China.

Methods. Questionnaires were collected from 3328 female adults aged 25-69 years in rural Anyang, China in 2009-2011. Hysterectomy status was ascertained by the gynecologist at the time of cytological test. Univariate and multivariate regression analyses were performed to assess the risk factors for hysterectomy.

Results. The overall prevalence of hysterectomy was 3.31% (110/3,328). Women above the age of 40 years had a higher prevalence of prior hysterectomy, compared to those aged 25-39 years (5.01% *vs.* 0.33%). Obesity was marginally related with a higher risk of hysterectomy (Adjusted OR=1.59; 95% CI, 0.99-2.56; body mass index (BMI) $\geq$ 28.0 vs. 18.5 $\leq$ BMI $<$ 24.0). History of prior pregnancy loss conferred a greater risk for hysterectomy (Adjusted OR=1.51; 95% CI, 1.02-2.23). Of the 75 (68.18%, 75/110) cases who provided further information on hysterectomy, 84.00% (63/75) had undergone total abdominal hysterectomy, and 70.67% (53/75) had received surgery for leiomyoma.

Conclusions. Rural Chinese women had a relatively low prevalence of hysterectomy, and the majority of reported hysterectomies were performed abdominally for leiomyoma. Hysterectomy prevalence differed significantly by age, body mass index, and history of pregnancy loss. This study expands the current understanding of the epidemiology of

hysterectomy in lower-resource areas.

Keywords Hysterectomy; prevalence; risk factors; indications; surgical types

Strengths and limitations of this study

1. This is the first study to demonstrate the prevalence of and factors associated with hysterectomy in a general population in rural China; one of the main strengths is, therefore, the population-based nature and low-resource setting of this study.

2. The use of hysterectomy status data ascertained by a gynecologist in a cervical cytology screening program in rural China, where no regional or national databases were available, enabled us to estimate the prevalence and risk factors of hysterectomy in this area.

3. The possibility of a response bias of participants may reduce the generalizability of our findings to a wider population.

4. The small number of hysterectomy cases may have affected the precision of our assessment of the predictors of hysterectomy.

INTRODUCTION

Hysterectomy is one of the most frequent surgical procedures performed on women in developed countries.[1] The epidemiology of hysterectomy in the female general population is of public health importance because this procedure may affect the population at risk for uterine diseases[2] and it may also be associated with significant socioeconomic and personal consequences when widely performed. Previous studies, mainly undertaken in developed regions, have shown that the prevalence of hysterectomy varies substantially by race and geographic area (4%-40%).[3-7] Education level, age at first birth, parity, number of miscarriages, and other potential risk factors have been inconsistently associated with the risk of hysterectomy.[5, 8-10] The indications for and surgical techniques used for hysterectomy have also been found to differ across regions[1, 4, 11-13]; however, in general, the major indication for hysterectomy is leiomyoma, and the dominant surgical type is abdominal hysterectomy.[1, 14]

Till now, the epidemiology of hysterectomy in developing countries, including China, remains largely unknown. This population-based cross-sectional study, among 3,328 rural Chinese women, seeks to: 1) assess the prevalence and risk factors of hysterectomy; and 2) investigate indications for and types of hysterectomy among identified cases.

METHODS

Study population

This population-based survey was part of an ongoing esophageal cancer cohort study in rural Anyang, China.[14] Anyang is an agricultural region of low-income with a per capita gross

domestic product (GDP) of US$3,672 (2010). Like in other rural areas of China, the New Rural Cooperative Medical Scheme (NRCMS, a government-run voluntary insurance programme), initiated in 2003, is a major health insurance programme in rural Anyang. In 2013, the per capita premium was $57.8, and NRCMS accounted for 99% of all rural residents in China.[15] The current investigation utilized a subset including 6 of the 9 target villages which were cluster-sampled in the parent cohort study conducted from 2009 to 2011. Eligibility criteria for subjects enrolled in this study were as follows: 1) female permanent residency in the target villages (registered in the China's unique household registration (Hukou) system); 2) aged 25-69 years; 3) no prior diagnosis of cancer (9 residents were excluded before enrollment because of self-reported history of cancer including 1 with cervical cancer), mental disorder, or cardiovascular disease; and 4) no past history of HBV, HCV, or HIV infection. All participants in this study provided written informed consent. This study was approved by the Institutional Review Board of the Peking University School of Oncology, China. The methods were carried out in accordance with the approved guidelines.

Measurements

Briefly, hysterectomy status was ascertained by a gynecologist at the time of gynecologic examination and cytological test. Data on sociodemographic factors, cigarette smoking (defined as at least one cigarette or more per day for at least one year), alcohol consumption (defined as the consumption of Chinese liquor two or more times per week for at least one year), reproductive history, and personal health habits (e.g., genital washing before sexual intercourse) were collected through face-to-face interviews before gynecologic tests on the same day. Height and weight were measured by the interviewers.

For cases reporting a hysterectomy, the time of the procedure along with the information on the indications for and surgical techniques used to perform hysterectomy were also recorded. In this study, the modes of hysterectomy were divided into six categories, including total abdominal hysterectomy (involving removal of the uterus and its attached cervix through an incision in the lower abdomen), subtotal abdominal hysterectomy (involving removal of only the uterine body, leaving the cervix intact, through an incision in the lower abdomen), vaginal hysterectomy (involving removal of the uterus via the vagina, without an abdominal incision), laparoscopic hysterectomy (involving the use of laparoscopy to perform hysterectomy), radical hysterectomy (involving removal of the uterus and resection of the ventral or lateral parametria), and other unspecified hysterectomy.

Statistical analysis

Prevalence estimates along with 95% confidence intervals (CI) were estimated using a null linear regression model implemented with the Generalized Estimating Equation (GEE) with a robust sandwich estimator of covariance to adjust for intracluster correlation.[16] The China 2010 Population Census data and the World Health Organization world standard population data were used for calculating the adjusted prevalence of prior hysterectomy.[17] Potential risk factors that were statistically significant in univariate GEE regression analyses were entered in the final multivariate GEE regression models. Significant differences between groups were quantified by calculating adjusted odds ratios (OR) and 95% confidence intervals (CI). Tests for linear trends were performed by treating ordered categorical variables as continuous variables in the GEE regression analyses. Linear regression models were used to determine whether any variables in the multivariate models were highly collinear. In this study, all

variance inflation factors were below 3.0 and therefore within the acceptable range.

Statistical analyses were performed using STATA version 12.0 (STATA Corporation, College Station, TX, USA). All statistical tests were two-sided at the 0.05 significance level.

RESULTS

Participant characteristics

Of 3,849 eligible candidates, 3,328 (86.5%) were enrolled in the study (the other 521 candidates, who were more frequently of younger age, did not participate, mainly because they were employed outside of Anyang). The median age of these 3,328 participants was 43 years. Most subjects were married or cohabiting (95.00%); of the participants, 92.85% had a level of education of less than 9 years, and 88.52% were engaged in farming (Supplementary Table S1). Both cigarette smoking (0.27%) and alcohol consumption (0.21%) were uncommon. Approximately one half of the women were overweight (31.40%) or obese (18.66%), 43.27% reported menarche at the age of ≤ 15 years, 39.84% had their first birth at the age of ≤ 22 years, 37.71% had a parity > 2, 43.66% reported having a history of fetal loss, 77.34% used an intrauterine contraceptive device, 37.89% reported having had a tubal ligation, and 8.80% had a history of post-intercourse bleeding.

Prevalence and risk factors for hysterectomy

The overall prevalence of prior hysterectomy was 3.31% (110/3328, 95% CI: 2.49-4.12). Adjusted estimates of prevalence standardized by the age structure of the female population

of China's 2010 Census and by the age distribution of the World Health Organization world standard population of 2001 were 3.21% and 3.03% respectively. Figure 1 shows the prevalence of prior hysterectomy according to five-year age groups. Among women age 25-39, 0.33% (4/1214) had no uterus (age25-29: 0.32%; age 30-34: 0.52%; age 35-39: 0.19%). The percentage rose to 7.22% (27/374) among women age 45-49. After age 50, the prevalence of prior hysterectomy declined somewhat (Figure 1). Women above the age of 40 years had a higher prevalence of prior hysterectomy compared to those aged 25-39 years (5.01 % *vs.* 0.33%, data not shown). Obesity was marginally related with a higher risk of hysterectomy (Adjusted OR=1.59; 95% CI, 0.99-2.56; body mass index (BMI) ≥ 28.0 *vs.* 18.5 ≤ BMI < 24.0) (Table 1). History of prior pregnancy loss conferred a greater risk for hysterectomy (Adjusted OR=1.51; 95% CI, 1.02-2.23) (Table 1).

Indications and surgical types for hysterectomy

A total of 75 (68.18%, 75/110) cases provided further information on hysterectomy, with mean age at time of hysterectomy of 44 years (standard deviation: 7.6 years; range: 27-66 years) (Supplementary Figure S1). Of these 75 cases, 70.67% (53/75) had a hysterectomy performed for leiomyoma, 10.67% (8/75) had a hysterectomy performed for dysfunctional uterine bleeding, 1.33% (1/75) had a hysterectomy performed for cervical cancer, and 6.67% (5/75) had a hysterectomy performed for other indications (Table 2). Total abdominal hysterectomy was the most common surgical technique (84.00%, 63/75), while other methods such as vaginal hysterectomy (2.67%, 2/75) and laparoscopic hysterectomy (1.33%, 1/75) each accounted for ≤ 3% of the total hysterectomies.

DISCUSSION

To our knowledge, this is the first study to demonstrate the prevalence of and factors associated with hysterectomy in a general population in rural China. Data from this study demonstrated that rural Chinese women had a low prevalence of hysterectomy. Obesity and history of prior pregnancy loss were associated with greater odds of hysterectomy. The most common indication for hysterectomy was leiomyoma, and the predominant procedure performed was abdominal hysterectomy. This investigation expands our knowledge about the epidemiological profile of hysterectomy in a low-income setting.

The overall prevalence of hysterectomy (3.3%) in our study was considerably lower than previous findings from studies conducted in developed countries such as the United States (26.2%), Ireland (22.2%), and Australia (22.0%)[18-21], but closer to that identified in Taiwan (8.8%) and Singapore (7.5%).[22, 23] Data on hysterectomy is limited in developing settings. Our estimated prevalence was in the lower range reported by community-based studies from low- and middle-income countries such as India, El Salvador and Jordan (1.7%-9.8%)[3, 24-31], similar to percentage reported among women textile workers in Shanghai, China (3.9%).[32] The low hysterectomy prevalence in this study population may be due to various reasons including limited availability of gynecology services, poor access to public/private sectors, and fear of surgical operations. Additionally, low affordability of medical care can be another explanation for the low prevalence. Based on data of China's National Health Survey in 2003, more than one-third of those who did not seek medical care while sick and over two-thirds of those who

refused hospitalization after professional referral reported 'excessive cost' as the major factor influencing their decisions.[33] The cultural norms associated with fertility-preserving treatment may also have contributed to the relatively lower prevalence of hysterectomy.[7, 34] The uterus, as the childbearing organ, is seen as the essence of womanhood in China. Some individuals may feel that they are no longer women after hysterectomy. Indeed, one previous study showed that Chinese-American women who were educated in China and presumably less acculturated into the American "hysterectomy-prone" culture had a low hysterectomy rate.[35]

Although the overall prevalence of hysterectomy was generally lower than the previously reported rates in high-resource regions, the pattern of the age distribution of prior hysterectomy prevalence was consistently similar.[4] The percentage of prior hysterectomy started to increase in women aged 40-49 years and thereafter remained relatively stable, which could be due to the sharp increase in hysterectomy incidence rates in this age group.[4, 36] In support of this reasoning, we observed that the average age at hysterectomy was 44 years and more than one-half of all hysterectomies were done in women age 40-49 in this study. According to previous investigations, this increase may be driven by the high occurrence of uterine leiomyoma, the main indication for surgically removing the uterus, among women aged 40-49 years.[36] Approximately one quarter of hysterectomies were performed in women younger than 40 years of age in this study. Evidence on the long-term side effects of hysterectomy suggests that hysterectomies, especially those performed at young age, are associated with earlier onset of menopause and higher risk of cardiovascular disease, urinary incontinence and problems with sexual function.[37-40] Research is required across China to monitor trends and track long-term health effects of hysterectomy.

For indications and surgical types for hysterectomy, similar to reports from Taiwan[6] and Western countries,[36, 41] leiomyoma of the uterus predominated among the medical conditions leading to hysterectomy in this study population; among women undergoing hysterectomy, abdominal hysterectomy was the most frequently performed procedure, also in agreement with most previous studies.[1, 4] However, the frequencies at which different types of hysterectomies were performed have been found to vary markedly across populations and over time, probably due to differences in healthcare resources, surgeon experience, and patient attitudes.[4, 18, 42] According to a Cochrane review of studies mainly conducted in Western countries, vaginal hysterectomy, which has become more widely performed, appeared to be superior to laparoscopic and abdominal hysterectomy for benign diseases, as it has been associated with a speedier return to normal activities due to smaller incisions.[42] However, there is limited evidence about the changes in hysterectomy rates over time and the relative superiority of hysterectomy approaches for addressing benign conditions in low-resource settings, and further research in this regard is needed.

In terms of predictors for hysterectomy, it should be noted that data on sociodemographic factors and behavioral characteristics as well as information about BMI status were only gathered at the time of interview, hence whether there was any change in these questionnaire data before or after a hysterectomy, if performed, is unknown. The following discussion was based on the assumption that the information of aforementioned variables remained unchanged before the interview. In this study, prior pregnancy loss was associated with greater odds of hysterectomy; this finding is consistent with previous reports.[5, 9, 41] Induced abortions have been commonly used in China since the 1970s as part of the national family

planning programme. According to surveys conducted in China, approximately 50% of women had prior abortions, primarily aiming to limit family size.[43, 44] Complications such as uterine perforation resulting from surgical abortion may lead to the application of hysterectomy as a treatment option.[45] In addition to being a risk factor, pregnancy loss may also be a reflection of uterine dysfunction that leads to an indication for hysterectomy. More qualitative research is needed regarding the biological and attitudinal links between prior fetal loss and hysterectomy, from both women's and physicians' perspectives. In terms of schooling, lower education level has been associated with a higher risk of hysterectomy; however, this association seems to vary by geographic location.[2, 12, 41, 46, 47] In this study, no correlation was found between education level and hysterectomy. Whether this null risk estimate was a true lack of association or merely due to insufficient statistical power because of the small number of hysterectomy cases and low proportion of women with high education levels included in our analysis is unclear. Concerning BMI, a higher hysterectomy frequency was observed in obese women in this study, confirming findings from other studies. [48] The correlation between obesity and hysterectomy can be partially explained by the fact that obesity elevates the risk of many gynecological conditions that may result in hysterectomy.[49] For instance, obesity has been reported to be associated with pelvic organ prolapse and uterine fibroids, which are common indications for hysterectomy.[50] Obese women are also more likely to develop endometrial carcinomas and pelvic inflammatory diseases, which are less common indications for hysterectomy.[49] Again, however, whether BMI status varied with undergoing hysterectomy is not determinable from the data at hand. Further studies with larger sample sizes are warranted to validate the factors affecting hysterectomy.

This study has some strengths and limitations. As regional or national databases in rural China are not as readily available as they are in developed countries, the use of hysterectomy status data ascertained by a gynecologist in a cervical cytology screening program among rural Chinese women enabled us to evaluate the prevalence and predictors of hysterectomy in this area. Thus, one of the main strengths of this study is the population-based nature and low-resource setting. The limitations of this study are as follows. First, the possibility of a selection bias (e.g. bias introduced by exclusion of individuals with a prior history of cervical cancer) may reduce the generalizability of our findings to a wider population. Second, due to the response bias of participants, there is no assurance that the epidemiological profile of hysterectomy observed here would hold true for the region as a whole. Third, self-reported maternal and reproductive characteristics may be subject to recall bias. Additionally, the small number of hysterectomy cases may have affected the precision of our assessment of the predictors of hysterectomy. Finally, due to the cross-sectional nature of this study, a temporal relationship cannot be inferred. Despite these limitations, our study still provides baseline information on the prevalence and predictors of hysterectomy, as well as indications for and procedures used in hysterectomies in rural China.

In summary, rural Chinese women had a relatively low prevalence of hysterectomy, which were largely performed abdominally for leiomyoma. Older age, obesity and history of prior fetal loss were associated with increased risk of hysterectomy among this study population. These findings provide insights into the hysterectomy epidemiology in lower-resource areas. Further studies are needed to monitor the trend of incidence rate of hysterectomy and modes of surgery over time.

CONTRIBUTORS

YK and HC were involved in the design and conducting of the survey. YP, YL, FL, QD, XL, ML, ZH, YL, JL, TN, CG, RX and LZ were involved in conducting the field work. FL and CZ performed the statistical analyses and wrote the manuscript text. All authors reviewed the manuscript.

ETHICAL APPROVAL AND INFORMED CONSENT

The study was approved by the Institutional Review Board of the School of Oncology, Peking University (Approval number: 2006020). All participants provided written informed consent. The methods were carried out in accordance with the approved guidelines.

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DATA SHARING

No additional data available.

CONFLICT OF INTEREST

The authors declare they have no conflict of interest with respect to this research study and paper.

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TABLES

Table 1. Prevalence of and risk factors for hysterectomy among women in rural Anyang, China, 2009-2011

Variables	Hysterectomy, No. (%)	No hysterectomy, No. (%)	Crude OR (95% CI)	Adjusted OR (95% CI)[a]	*P* value[a]
Total	110 (3.31)	3,218 (96.69)			
Age (years)					
25-40	4 (3.64)	892 (27.72)	1.00	1.00	
41-56	66 (60.00)	1,527 (47.45)	9.52 (3.53, 25.64)	7.82 (2.87, 21.31)	<0.001
57-69	40 (36.36)	799 (24.83)	11.04 (4.02, 30.31)	10.10 (3.48, 29.32)	<0.001
P_{trend}[b]			<0.001	<0.001	
Marital status					
Never married, divorced, separated or widowed	5 (4.63)	177 (5.59)	1.00		
Married or cohabiting	103 (95.37)	2,992 (94.41)	1.24 (0.50, 3.12)		
Type of employment					
Farming	101 (93.52)	2,845 (89.78)	1.00		
Non-farming	7 (6.48)	324 (10.22)	0.61 (0.28, 1.32)		
Education level					
Illiteracy (<1 year) or primary school (1-6 years)	72 (66.67)	1,814 (57.33)	1.00		
Junior high school (7-9 years)	31 (28.70)	1,173 (37.07)	0.67 (0.44, 1.03)		
Senior high school or above (>9 years)	5 (4.63)	177 (5.59)	0.71 (0.28, 1.79)		
P_{trend}[b]			0.085		
Household annual income, RMB					
≤10,000	23 (35.94)	511 (30.42)	1.00		
10,001-29,999	17 (26.56)	534 (31.79)	0.71 (0.37, 1.34)		
≥30,000	24 (37.50)	635 (37.80)	0.86 (0.48, 1.54)		
P_{trend}[b]			0.643		
Cigarette smoking					
Never	108 (100.00)	3,160 (99.72)	1.00		

Ever	0 (0.00)	9 (0.28)	NE		
Alcohol consumption					
Never	107 (99.07)	3,163 (99.81)	1.00		
Ever	1 (0.93)	6 (0.19)	4.89 (0.58, 41.33)		
Body mass index (BMI), Kg/m^2					
Normal weight (18.5 ≤ BMI < 24.0)	40 (36.70)	1,358 (44.42)	1.00	1.00	
Overweight (24.0 ≤ BMI < 28.0)	34 (31.19)	1,011 (33.07)	1.15 (0.72, 1.84)	1.06 (0.66, 1.70)	0.815
Obese (BMI ≥ 28.0)	34 (31.19)	587 (19.20)	2.01 (1.26, 3.22)	1.59 (0.99, 2.56)	0.054
Underweight (BMI < 18.5)	1 (0.92)	101 (3.30)	0.35 (0.05, 2.51)	0.38 (0.05, 2.94)	0.355
P_{trend}[b]			0.061	0.223	
Age (years) at menarche					
≤15	46 (42.99)	1,394 (44.45)	1.00		
16-18	45 (42.06)	1,391 (44.36)	0.98 (0.64, 1.49)		
≥19	16 (14.95)	351 (11.19)	1.38 (0.77, 2.46)		
P_{trend}[b]			0.437		
Menstruation					
Regular	73 (68.22)	2,223 (70.80)	1.00		
Irregular	34 (31.78)	917 (29.20)	0.88 (0.58, 1.34)		
Age (years) at first birth					
≤22	53 (49.53)	1,273 (40.84)	1.00		
23-24	31 (28.97)	1,102 (35.35)	0.68 (0.43, 1.07)		
≥25	23 (21.50)	742 (23.80)	0.75 (0.46, 1.23)		
P_{trend}[b]			0.166		
Parity					
≤2	53 (49.07)	1,939 (61.77)	1.00	1.00	
>2	55 (50.93)	1,200 (38.23)	1.72 (1.16, 2.53)	1.05 (0.67, 1.64)	0.842
History of fetal loss					
Never	50 (45.45)	1,825 (56.71)	1.00	1.00	
Ever	60 (54.55)	1,393 (43.29)	1.56 (1.06, 2.30)	1.51 (1.02, 2.23)	0.038

Use of intrauterine contraceptive devices			
No	29 (26.85)	669 (21.14)	1.00
Yes	79 (73.15)	2,495 (78.86)	0.72 (0.47, 1.11)
Tubal ligation			
No	63 (58.33)	1,948 (61.57)	1.00
Yes	45 (41.67)	1,216 (38.43)	1.15 (0.78, 1.69)
History of cervicitis			
Never	91 (86.67)	2,534 (85.18)	1.00
Ever	14 (13.33)	441 (14.82)	0.89 (0.50, 1.58)
History of vaginitis			
Never	80 (76.19)	2,410 (80.95)	1.00
Ever	25 (23.81)	567 (19.05)	1.32 (0.83, 2.09)
History of pelvic inflammation			
Never	104 (96.30)	2,794 (93.92)	1.00
Ever	4 (3.70)	181 (6.08)	0.59 (0.21, 1.63)
History of post-intercourse bleeding			
Never	98 (91.59)	2,856 (90.96)	1.00
Ever	9 (8.41)	284 (9.04)	0.92 (0.46, 1.84)
Genital washing before sex			
Rare	86 (79.63)	2,329 (73.52)	1.00
Occasional	11 (10.19)	400 (12.63)	0.75 (0.39, 1.41)
Often	111 (10.19)	439 (13.86)	0.67 (0.36, 1.28)
P_{trend} [b]			0.162

Abbreviations: OR, odds ratio; CI, confidence interval; GEE, Generalized Estimating Equation; NE, not estimable.

[a] Variables that were statistically significant in univariate GEE regression analyses were included in multivariate models. Adjusted ORs, 95% CIs and *P* values were calculated by multivariate GEE regression model including age group, body mass index, parity, and history of fetal loss.

[b] *P* values for trend were calculated by GEE regression analyses, treating categorical variables as continuous variables.

Table 2. Indications for and types of surgery among the 75 hysterectomy cases from rural Anyang, China, 2009-2011

Procedure	Leiomyoma	Dysfunctional uterine bleeding	Cervical cancer	Other	Total
	No. (%)				
Total abdominal hysterectomy	49 (92.45)	8 (100.00)	1 (25.00)	5 (50.00)	63 (84.00)
Subtotal abdominal hysterectomy	1 (1.89)	0 (0.00)	0 (0.00)	1 (10.00)	2 (2.67)
Vaginal hysterectomy	0 (0.00)	0 (0.00)	0 (0.00)	2 (20.00)	2 (2.67)
Laparoscopic hysterectomy	1 (1.89)	0 (0.00)	0 (0.00)	0 (0.00)	1 (1.33)
Radical hysterectomy	0 (0.00)	0 (0.00)	2 (50.00)	0 (0.00)	2 (2.67)
Other unspecified hysterectomy	2 (3.77)	0 (0.00)	1 (25.00)	2 (20.00)	5 (6.67)
Total	53 (100.00)	8 (100.00)	4 (100.00)	10 (100.00)	75 (100.00)

FIGURE LEGEND

Figure 1. The prevalence of prior hysterectomy (%) according to five-year age groups among 3,328 rural Chinese women, 2009-2011. The numbers of women in the 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, and 65-69 years age groups were 313, 384, 517, 633, 374, 344, 365, 330, and 68 respectively.

Supplementary Figure S1. Age at time of hysterectomy among 75 cases wjth detailed information on hysterectomy

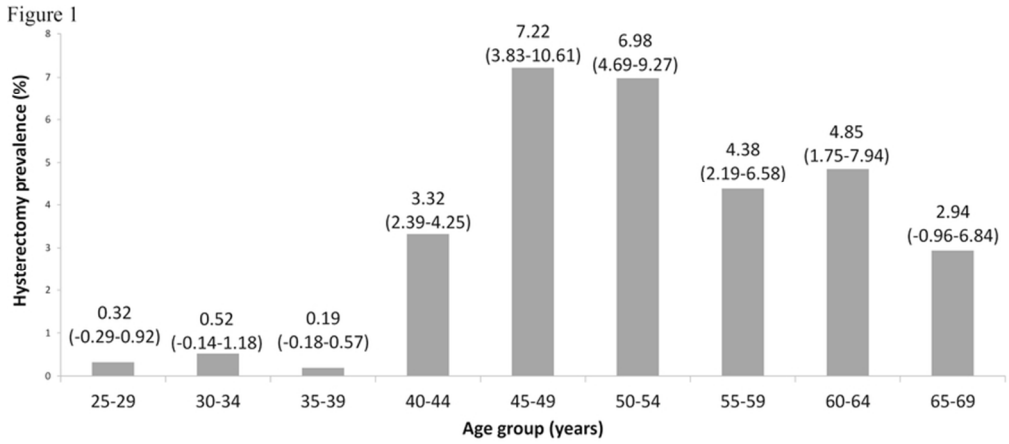


Figure 1. The prevalence of prior hysterectomy (%) according to five-year age groups among 3,328 rural Chinese women, 2009-2011. The numbers of women in the 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, and 65-69 years age groups were 313, 384, 517, 633, 374, 344, 365, 330, and 68 respectively.

74x32mm (300 x 300 DPI)

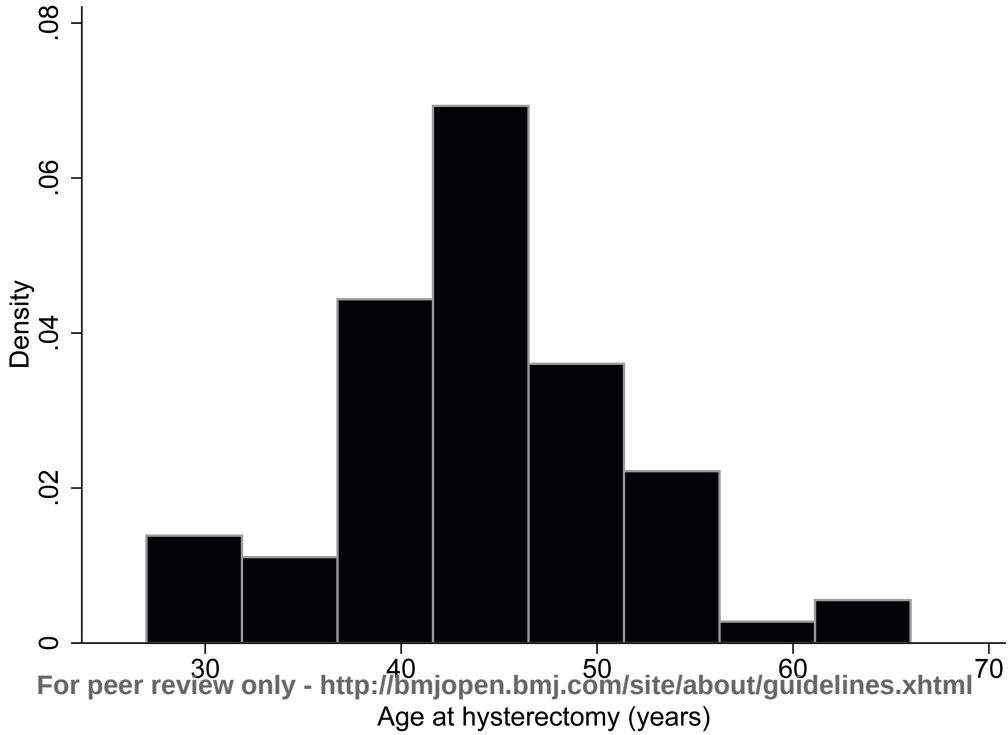
Supporting Information

Supplementary Table S1. Selected characteristics of women included in the study of hysterectomy in rural Anyang, China, 2009-2011

Variables	No. (%)
Total	3,328 (100.00)
Age (years)	
Median (Interquartile range)	43 (36-54)
25-40	896 (26.92)
41-56	1,593 (47.87)
57-69	839 (25.21)
Marital status	
Never married, divorced, separated or widowed	182 (5.47)
Married or cohabiting	3,095 (95.00)
Unknown	51 (1.53)
Type of employment	
Farming	2,946 (88.52)
Non-farming	331 (9.95)
Unknown	51 (1.53)
Education level	
Illiteracy (<1 year) or primary school (1-6 years)	1,886 (56.67)
Junior high school (7-9 years)	1,204 (36.18)
Senior high school or above (>9 years)	182 (5.47)
Unknown	56 (1.68)
Household annual income, RMB	
≤10,000	534 (16.05)
10,001-29,999	551 (16.56)
≥30,000	659 (19.80)
Unknown	1,584 (47.60)
Cigarette smoking	
Never	3,268 (98.20)
Ever	9 (0.27)
Unknown	51 (1.53)
Alcohol consumption	
Never	3,270 (98.26)
Ever	7 (0.21)
Unknown	51 (1.53)
Body mass index (BMI), Kg/m^2	
Normal weight ($18.5 \leq BMI < 24.0$)	1,398 (42.01)
Overweight ($24.0 \leq BMI < 28.0$)	1,045 (31.40)
Obese ($BMI \geq 28.0$)	621 (18.66)

Underweight (BMI < 18.5)	102 (3.06)
Unknown	162 (4.87)
Age (years) at menarche	
≤15	1,440 (43.27)
16-18	1,436 (43.15)
≥19	367 (11.03)
Unknown	85 (2.55)
Menstruation	
Regular	2,296 (68.99)
Irregular	951 (28.58)
Unknown	81 (2.43)
Age (years) at first birth	
≤22	1,326 (39.84)
23-24	1,133 (34.04)
≥25	765 (22.99)
Unknown	104 (3.13)
Parity	
≤ 2	1,992 (59.86)
> 2	1,255 (37.71)
Unknown	81 (2.43)
History of fetal loss	
Never	1,875 (56.34)
Ever	1,453 (43.66)
Unknown	
Use of intrauterine contraceptive device	
No	698 (20.97)
Yes	2,574 (77.34)
Unknown	56 (1.68)
Tubal ligation	
No	2,011 (60.43)
Yes	1,261 (37.89)
Unknown	56 (1.68)
History of cervicitis	
Never	2,625 (78.88)
Ever	455 (13.67)
Unknown	248 (7.45)
History of vaginitis	
Never	2,490 (74.82)
Ever	592 (17.79)
Unknown	246 (7.39)
History of pelvic inflammation	
Never	2,898 (87.08)
Ever	185 (5.56)
Unknown	245 (7.36)

History of post-intercourse bleeding	
Never	2,954 (88.76)
Ever	293 (8.80)
Unknown	81 (2.43)
Genital washing before sex	
Rare	2,415 (72.57)
Occasional	411 (12.35)
Often	450 (13.52)
Unknown	52 (1.56)



STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3,4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5,6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5,6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	5,6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6,7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	7
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8,9
		(b) Give reasons for non-participation at each stage	8,9
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8,9
		(b) Indicate number of participants with missing data for each variable of interest	8,9
Outcome data	15*	Report numbers of outcome events or summary measures	8,9
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8,9

		(*b*) Report category boundaries when continuous variables were categorized	21,22,23
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	9,10
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13,14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11,12,13
Generalisability	21	Discuss the generalisability (external validity) of the study results	13,14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.